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January 31, 1929

Engineering News-Record

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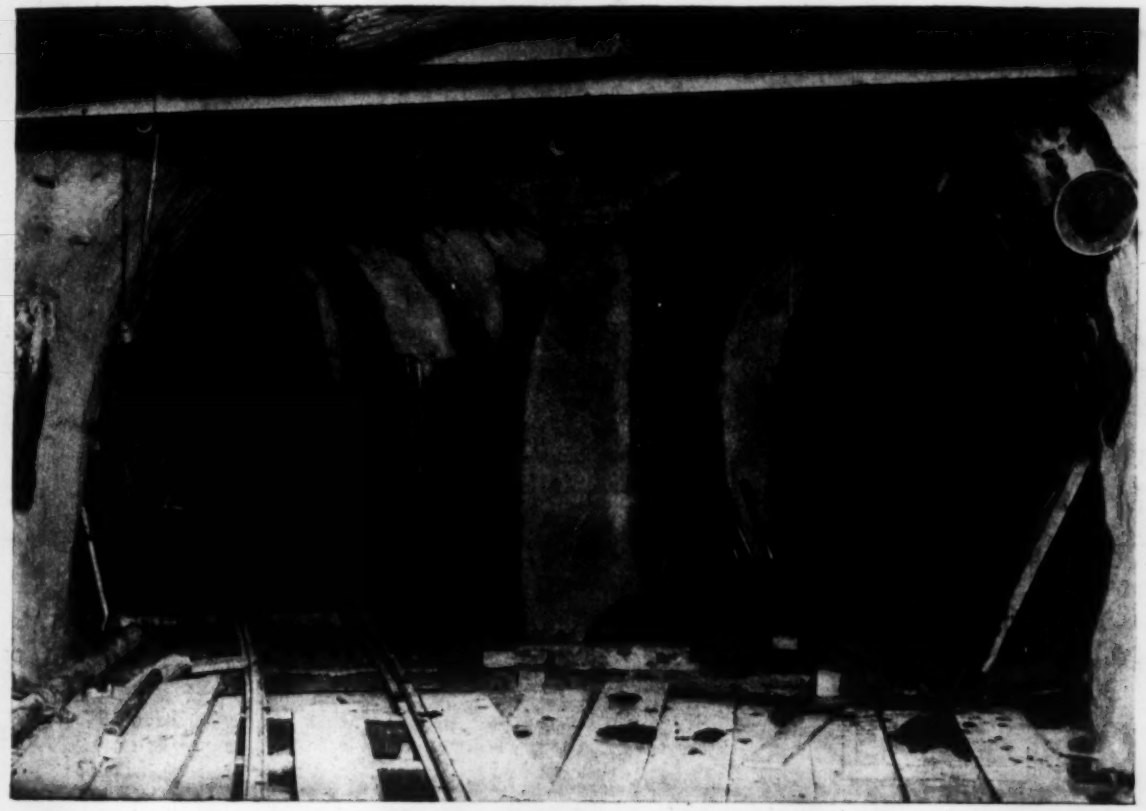

Cross-cut, Indian Creek Shaft, Hetch Hetchy Tunnels

Building Wide Boulevards in San Francisco

Progress on the Hetch Hetchy Water Supply Tunnels

Tower Erection by Creeper Method on Detroit Bridge

Effect of Temperature on Strength of Concrete

Special Board Reports on Slumping of Lafayette Dam

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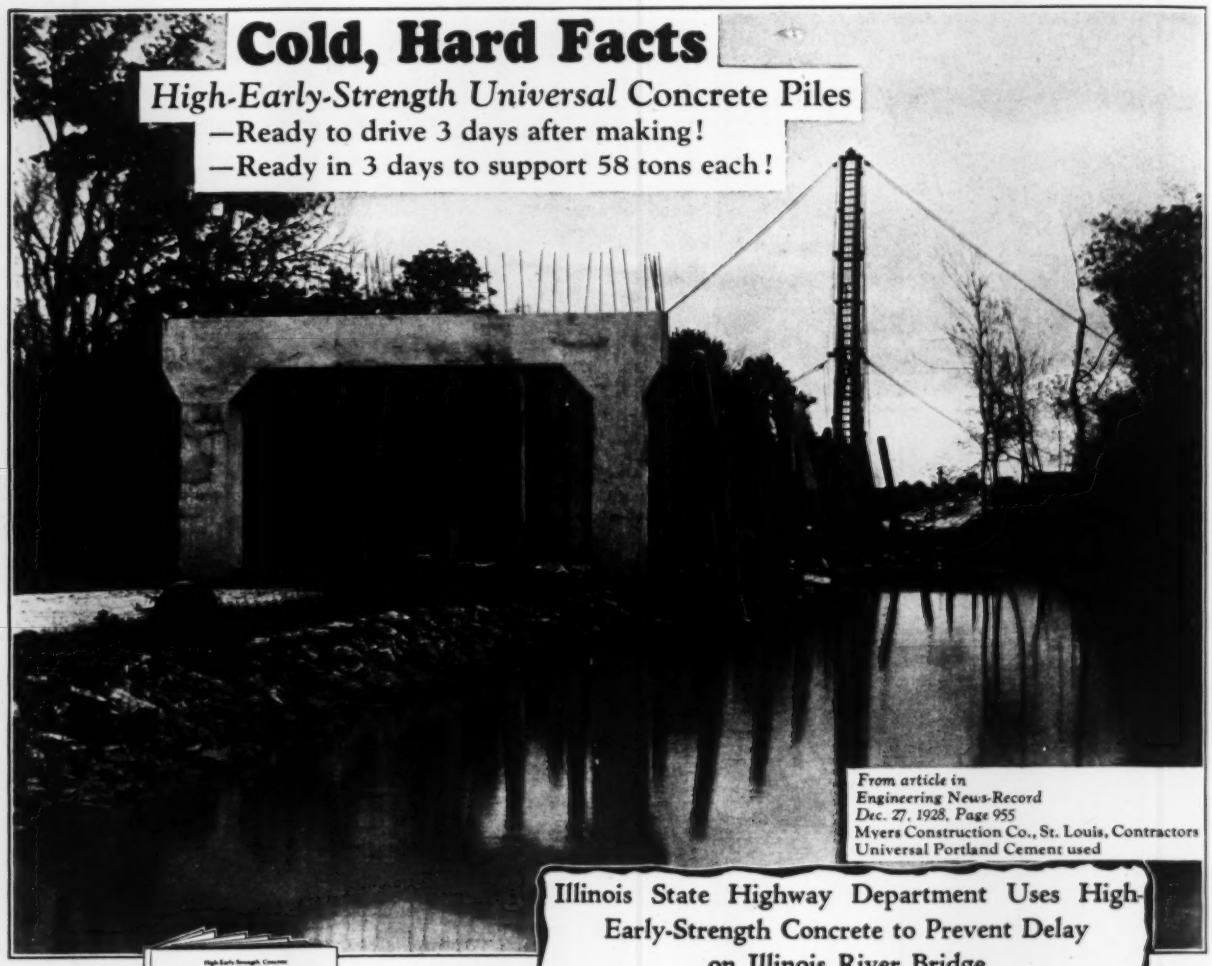
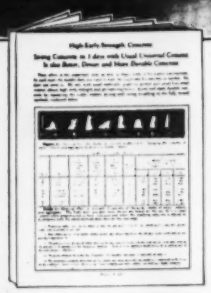


From article in
Engineering News-Record
Dec. 27, 1928, Page 955
Myers Construction Co., St. Louis, Contractors
Universal Portland Cement used

Illinois State Highway Department Uses High-Early-Strength Concrete to Prevent Delay on Illinois River Bridge

PRECAST concrete piles, 50 ft. long, of concrete with an average three-day compressive strength of 3,765 lb. per sq.in., made with standard portland cement, were used this year by the Illinois State Highway Department for a bridge over the Illinois River at Florence. In three days the piles were ready to be driven 35 ft. into the ground. A cross-section of the type of structure is shown in Fig. 1, and Fig. 2 shows the piledriver and

Tests—At three days test cylinders cured under field conditions were broken under the 200,000-lb. testing machine in the state highway testing laboratory at Springfield. The average slump on test cylinders from four different piles was about 2 in. The highest test showed 4,482 lb. per sq.in. at three days. The average for the four piles was 3,765 lb. The load-carrying capacity of the individual piles, based on the weight of the hammer, the distance of the fall and the degree of penetration, was 58 tons each, or more than twice the load (27 tons) specified on the state plans.



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New York, January 31, 1929

Engineering News-Record

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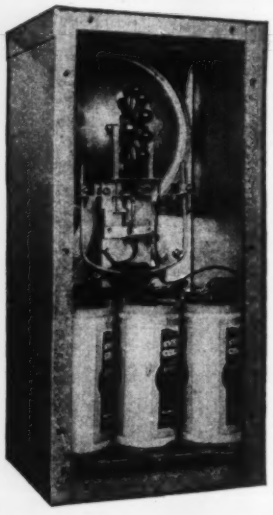

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Volume 102 NEW YORK, JANUARY 31, 1929 Number 5

"Dead Ahead"

"PROCEEDING at full speed on our new course, her radio signals were getting stronger all the time. As darkness came on . . . we sighted the 'Florida' dead ahead." In these terse words Capt. George Fried told the world of a new triumph of science over the dangers of the sea. Disabled, with her bridge and most of her navigating instruments and books swept away, the freight steamer "Florida" was in desperate plight. But her radio apparatus was still functioning, and through its operation the captain of the "America," guided by his radio compass, was able to reach the ship as darkness fell. The efficacy of one of the newest aids to navigation upon the high seas was proved by that supreme test. By no other means than radio communication could the exact position of the "Florida" have been determined, and by no other means than the radio compass could the "America" have plowed through the rough sea at full speed ahead with constant assurance that her direction was correct. Under like circumstances a few years ago the "Florida" would have been reported, weeks afterward, as lost with all hands. Today by virtue of a creation of science all hands are safe ashore.

Wider Boulevards

WHEN a new highway is built the number of automobiles in the community it serves has a habit, most disconcerting to the engineer, of increasing to such an extent that the roadway goes into service with nothing like the expected reserve capacity. Boulevards attract traffic in like manner, and foresight is essential to planning a boulevard system that will be adequate for even a moderate period after completion. San Francisco has been developing a boulevard network for some fifteen years, beginning with funds made available by gasoline taxes and more recently, since the value of the wide roadways has become better appreciated, with funds provided by bond issues. It is notable that two recent bond issues totaling some $11,000,000 carried by three to one majorities. In considering bond issues for boulevards, California cities have the advantage of object lessons throughout the state in the rapid growth of automobile traffic. The ratio of automobiles to population has increased by leaps and bounds, and coincident with that change has come a need for wider roadways and a widespread appreciation of their value. The state highway commission has established a 100-ft. right-of-way width as the minimum in laying out new trunk routes, even where only a narrow pavement is to be put down at first. With adequate right-of-way the surface can be widened as traffic increases. In the new San Francisco boulevard system, where all traffic from the city is restricted to one direction down the peninsula, the right-of-way is nowhere less than 100 ft., and in some cases even greater. The city's automobile ratio has been low because congested streets and the limitations imposed by ferries have lessened the opportunity to use automobiles. It is significant, however, that the number of cars has increased tenfold in the past ten years and that the city engineer predicts a doubling of automobile registration within two years. Adequate facilities for the use of motor vehicles are essential to the city that expects to progress.

Modern Pioneering

A WORD was said at the ceremonial opening of the Cascade tunnel, a week or two ago, that brings to mind a lasting truth. Ralph Budd, president of the Great Northern Railway, in his opening address turned back to the memorable pioneering done by James J. Hill in projecting and carrying through the line, many years ago. Then W. W. Atterbury, president of the Pennsylvania Railroad, in comparing the present achievement in driving the great tunnel with the work of the older days, characterized the modern undertaking as "a new kind of pioneering." To repeat his own words, there is just as much pioneering today as there was formerly. Today's problems call for originality and initiative as much as the problems of a half-century back. There are those who break new paths even today, and it is they who stand out among men as leaders and as representatives of great achievement. This will always be true so long as men work and strive; each day and each year brings its new problems, and the attack upon them will always call for the resourcefulness and courage of the pioneer. So, among others, do the railroads of today depend on the creative power of conception, upon the vision of the trail-breaker and the builder as fully as they they did in the era when the lines were pushed forward across the continent. The railroad's future depends for progress and success upon the pioneers whom it is able to enlist in its ranks. Without modern pioneers they can have no great future.

Specifying Wood Preservation

FOR almost as long a period as wood preservation has been carried on as a commercial undertaking the amount of preservative has been specified on the basis of the amount retained per cubic foot of wood, with little regard to the dimensions of the timber being treated. The results obtained by this method were reasonably satisfactory when preservative treatment was applied chiefly to track ties and heavy bridge timber, but now that treated timber is being put to so many other uses where lumber of varying shapes and sizes is used a somewhat different specification is required in order to get uniform results. At the recent meeting of the American Wood Preservers' Association, J. D. MacLean, of the U. S. Forest Products Laboratory, proposed a method of specifying the amount of preservative in which the relation of volume to surface area of the timber is used. Obviously, for practical reasons, such a specification cannot take into consideration all sizes of lumber, but by

grouping related sizes it does appear as if a better method of specifying could be drawn up on such a basis. Mr. MacLean's recommendations deserve careful consideration by all interested in the subject of wood preservation. They are reproduced in abbreviated form in this issue.

The Short Lines Again

THE prospect for some action by the present Congress upon railroad consolidation is not bright, despite the fact that a bill to facilitate such consolidations is now before the Senate committee on interstate commerce and is reported to have the approval of the administration. So little time remains before adjournment that any opposition to the bill—of which there is sure to be some—will make final action impossible. Meanwhile the Interstate Commerce Commission continues to take what limited action it may. On Saturday it approved the New York Central's plan for leasing the Michigan Central, the Cleveland, Cincinnati, Chicago & St. Louis and some smaller controlled lines, conditioning its approval upon the New York Central's offering to buy certain short-line railways which connect with it but are not now owned or controlled by it. The company, however, is not required to purchase the lines if a reasonable offer by it is not accepted. Short lines and minority interests are the stumblingblocks in most consolidation plans. If some scheme can be evolved for protecting their interests without permitting them to hold up the purchasing railroad for a price out of all proportion to the true value of their holdings, a long step toward an effective railroad consolidation law will have been made. The outcome of the Interstate Commerce Commission's ruling on this point in the New York Central case will be watched with interest.

Wrestling With Traffic

ONLY within the last week, long after the successful Chicago experiment of traffic reform by a sweeping no-parking order, New York City has undertaken a strenuous attempt to rescue itself from the mess of street-traffic difficulties by belated and therefore fairly drastic action. For years the city has been tied up, increasingly so, by the joint effect of excessive traffic, reckless closing of streets and a bad traffic-control system. The latter, an early development, operated for years under non-progressive city-official and police direction, is characterized by long time-intervals, signals spaced a quarter-mile or more apart and located on the north-south streets only, and an absence of all restrictions on turns. Superadded to this was an amazing amount of hack cruising. Such conditions are peculiarly serious in a region laid out as is the Borough of Manhattan, which has few longitudinal streets and whose cross-streets, though closely spaced, are narrow. When some of the longitudinal streets are closed to traffic by inexcusable negligence in the conduct of construction operations (such as subway building) and when most of the cross-streets are so throttled by parking that even one-way traffic rules do not enable the single file of moving vehicles to get through at reasonable speed, the gravity of the resulting traffic congestion can well be imagined. A new police commissioner, hoping to solve the problem in one blow, has put a radical set of control rules in force for evening use in the mid-town and theater district. Its chief features are the prohibition of parking, a prohibition of all turns (right as well as left) and a shorter time-interval of the traffic signal system. Very naturally, these measures at once brought about a marked improvement in the facility of traffic movement, though of course the improvement in convenience to the street user has also a large negative element. At all events, the innovation is a hopeful beginning of reform in a seriously neglected traffic situation, and represents a definite attempt to put some sense into traffic management in New York. It emphasizes the dominating position which traffic problems are assuming in city life, and the complex engineering character of the operations involved. The evolution of definite engineering study of traffic problems and traffic control methods is rapidly approaching.

Construction Requirements on the Mississippi

THE review of contracting prospects and problems on the Mississippi which is concluded in this issue conveys a definite lesson. It is that success in putting the flood-control work under contract calls for determined co-operation and co-ordination. The engineers directing the work have the task of providing every opportunity for intelligent estimating and planning; the contractors are under the requirement of learning the special construction problem and of directing their best efforts to its skillful solution. There cannot be too great insistence on this mutual obligation of the flood-control engineers and contractors.

In the engineering direction mere willingness to give the contracting industry its opportunity to bid for construction will not meet the requirements. There must be definite effort to encourage contracting and aid it to bid intelligently and conduct its operations profitably. This calls for a revised viewpoint and practice. In the past, on the river work the contractor has been suffered rather than encouraged to undertake levee construction. In the field of revetment building he has not even been considered.

These statements are not made in a mood of recrimination but to express plainly a situation that has come about as a result of repressions and growths for which both contractors and government engineers are responsible. The new flood-control construction sets a new scene for action which calls for expression along a new line. It is evident in any close study of the flood-control construction practices that thinking is still of a time when millions and not tens of millions were the basis of planning. Operations which this year are highly mechanized, with giant tractors and trailers in action, still show clearly a continuation of the mule-team thinking of past years.

It is natural that this should be so at the beginning. It is vitally important that it should not continue. In seeing to this the engineers have a greater obligation of reform and leadership than has the contractor. They must initiate the new mental attitude, on the one hand by making known more fully than has ever been the case the need of, and the conditions affecting, efficiency of field operations, and on the other hand by giving ample time in asking bids, so that contractors can make a reasonably complete study of proposed undertakings. They have a duty in planning larger and longer contracts and of developing continuing contracts. The accomplishment is not difficult; it is the will to accomplish that needs spurring.

There is no less need for the contractor to sense the changed situation. Unless he can appraise the new construction conditions and obligations of flood-control work in all their implications of new equipment and methods and new management policies and practices he has no place as a principal in that undertaking. Indeed, his obligation extends to being the inventor and promoter of construction processes and procedure. Once the conditions are plainly set forth by the engineer, he must prove by his works his right of leadership in invention and skill in construction.

Throughout the group of articles completed in this issue there is implied an obligation of co-operation and co-ordination on the new flood-control work whose neglect the public will not be slow to sense. Should it find such neglect, it will count it against the support and continuance of flood control. A very little departure from present thinking on the traditional lines of Mississippi contracting and engineering will spell high success to one of the greatest national public works ever undertaken. It behooves engineering and contracting to keep this fact close in their thoughts if engineering construction is to emerge with full credit.

Misleading Cost Figures

GROSSLY misleading figures are constantly being given out on the cost of sewage treatment. This is notably true as regards revenue derived from reclaiming the fertilizing material in sewage. A recent and glaring case in point arises from the paper on the activated-sludge plant at Milwaukee, presented Jan. 17 before the Sanitary Engineering Division of the American Society of Civil Engineers. The statement was made that the sludge recovered for sale for fertilizing purposes brought $600,000 against operating expenses of $900,000 so that the receipts equaled two-thirds of the operating expenses. But why stop with operating expenses? Why did not the reporters give a true cost picture by taking capital charges into account?

This brings up another grossly misleading factor in figures commonly given out regarding the cost of municipal enterprises. That is ommission in construction cost totals of interest charges and other items accruing between spending the first dollar for legal, engineering and other purposes and finally putting the plant into operation. At Milwaukee, for instance, there was a long period of large-scale research work before the construction of the activated-sludge plant began. Then several years were passed in construction work. During all this time salaries and various other expenses were piling up and interest had to be paid on the yearly totals. Since the Milwaukee plant went into operation, research has been continued. It is still going on. This is all to the credit of those in charge of the Milwaukee project, but certainly a considerable portion of the cost should be charged against the treatment plant.

Depreciation is a large factor in any activated-sludge plant for the treatment of sewage. This has been shown at Milwaukee, Houston and Pasadena, where in each case a material portion of the sludge-dewatering equipment had to be scrapped shortly after it was put into operation and something different installed.

Whether the cost accounts for these three plants are so kept as to show the capital outlay from year to year we are unable to state, but certainly to compare fertilizer sales at Milwaukee and Pasadena with operating expenses and leave capital charges out of account is grossly misleading. This should be taken into consideration whenever rosy claims are being made for the revenue derivable from the activated-sludge process or whenever this process is being compared with other methods of sewage treatment. As we have already intimated, engineers (or some of them) realize this, but not so the general public, which has to foot the bill and is so often misled by fragmentary information. Engineers should lead in proper cost accounting not merely for sewage-works but for other public works as well.

Plastic Foundations

THE REPORT of the consulting board that has been studying Lafayette dam, a rolled-earth structure which subsided 24 ft. during construction, finds that the slump was caused by plasticity in the deep alluvium under the dam. It holds that there was no defect in the structure itself and that the dam would have been amply safe as designed if it had been built on an adequate foundation. To those interested chiefly in the principle involved this is a comforting outcome of the investigation, because it leaves unshaken the confidence that has long been associated with rolled-earth embankments. Yet we face the significant fact that the satisfactory materials and the excellent workmanship were no protection whatever when the plastic material beneath the structure began to move.

"Only in the light of exceptional experience could the mobility of this foundation material have been anticipated," says the board. In the future, however, whenever foundations involve deep alluvium which may contain plastic material, the careful engineer will profit by the Lafayette experience and will make a very searching analysis. It is not always possible to avoid clay seams altogether, but they must not be allowed to become the seat of slips or flows. Not only must excess water be excluded from material that becomes plastic when wet but there must be assurance that such material underlying a proposed dam site does not already contain enough moisture to permit movement under the proposed loading.

The Lafayette consulting board shows the thoroughness of its investigations when it confidently recommends that the dam be completed to a height of 100 ft.—that is, to within 40 ft. of the original height—the only change in the program being the use of 5 to 1 and 7 to 1 slopes on upstream and downstream sides, respectively. These flat slopes give the section remarkably conservative lines and make it feasible to complete the structure on a modified program without prohibitive cost increase.

All things considered, the slipping of Lafayette dam has been a most fortunate and instructive event. No lives or property (other than the dam itself) were menaced, and there had been neither storage in the reservoir nor ponding in construction of the fill to create complications by raising doubt as to the source of troublesome moisture. Test borings after the slump clearly show how hydrostatic pressures in the foundation were affected by the weight of the fill; and under these conditions the movement of plastic material that occurred was a natural result. The partial failure of Lafayette dam has given a full-sized loading test several months in duration that contributes valuable information to the art of dam building.

Building Wide Boulevards in San Francisco

Work Begun Fifteen Years Ago With Gasoline Tax Funds Is Speeded by Bond Issues—Local Network Feeds Trunk Routes Leading to State Highways

By L. B. Cheminant
Assistant City Engineer, San Francisco, Calif.

TWO BOND issues recently passed in San Francisco have made available $10,780,000 for the more expeditious construction of boulevards which have been under way in that city with gasoline tax funds since 1913. The present program is to extend the existing boulevard network within the city so as to afford needed main outlets to state highway routes down the peninsula. Nine boulevard projects are now under way, seven of which were designed to improve traffic conditions on routes leading to the San Francisco-San Mateo county line, which crosses the natural peninsula outlet almost at right angles.

A notable feature of these new roadways is the right-of-way widths; one exceeds 300 ft. and the narrowest of those now under construction has a paved roadway 80 ft. wide on a 100-ft. right-of-way. Cuts up to 52 ft. in depth are involved. Right-of-way widths have been fixed by natural limitations rather than by any attempt to make the number of traffic lanes bear some relation to traffic counts. The rapidity of increase in the number of cars and the enormous traffic peaks on holidays center attention on the primary problem of making boulevards wide enough with the funds available.

The vehicular traffic problem in San Francisco centers around the city's isolation on the tip of a peninsula with the Pacific Ocean on the west and the Bay of San Francisco north and east. Eight major ferry lines do their best to transfer automobiles across the bay on routes ranging in length from 4 to 30 miles, but despite the fact that intervals between boats are as short as six minutes on some runs, the ferry facilities are inadequate whenever the motorists turn out in force.

In a land area of 43 square miles the city now has a population of approximately 700,000, and automobile registrations total 150,000. Discouraged by the wait entailed in making a bay crossing by ferry, motorists turn to routes that lead down the peninsula to the south. However, the southern boundary of the city, about 6 miles long, is so traversed by spurs of San Bruno Mountain that there are only three natural outlets for vehicular traffic. On one of these, traffic counts have shown up to 30,000 vehicles in a sixteen-hour period. Because of this situation it has been necessary to consider the highways through San Mateo County as part of the San Francisco boulevard problem.

In 1913 a boulevard plan was projected by M. M. O'Shaughnessy, city engineer, and a gradual development program was formulated. At that time practically the entire cost of the work had to come out of the city's share of the state gasoline tax.

The 1913 work began with the construction of arteries to facilitate traffic between business centers and to make

PREPARING SUBGRADE OF 125-FT. BOULEVARD
Pavement 100 ft. wide will provide new connection with peninsular highways.

HEAVY ROCK GRADING ON BAY SHORE BOULEVARD
After blasting, power shovel loads trucks from successive bench cuts.

scenic points within the city accessible. All of the 1913 program, including more than 20 miles of boulevards, has been completed with the exception of Bernal cut, which is now being put through. This project involved a cut 4,200 ft. long of depths ranging up to 52 ft., and its construction was put off from time to time until a bond issue of $1,400,000 was passed in June, 1927. That was the first bond issue in San Francisco expressly for a boulevard.

APPLYING CURING COMPOUND TO CONCRETE PAVEMENT
Paved roadway 80 ft. wide laid in alternate 20-ft. strips.

Among the projects completed with gasoline tax funds are the Marina boulevard, 100 ft. wide and 4,500 ft. long, skirting the bay shore on the north edge of the city; Hunter's Point boulevard, 80 ft. wide and 10,300 ft. long; Twin Peaks boulevard, 40 ft. wide and 2 miles long, encircling Twin Peaks at El. 900; Market St. extension, 70 ft. wide, winding 7,200 ft. around Twin Peaks to the boulevard system beyond; and Sloat boulevard, 135 ft. wide and 2 miles long, leading out to the ocean beach.

Popular appreciation of wide roadways that resulted from building those listed above brought two new factors into the problem: (1) There was a great demand for wider outlets in order that motorists could get to and from the city by way of the peninsula, and (2) favorable public sentiment had developed to the point where it was practicable and needful to finance further boulevard construction by bond issue instead of the slower method of financing by taxation. This is true despite the material increase in gasoline tax funds that has attended increased automobile registration The income from this source has increased from $100,000 per annum in 1913 to about $1,000,000 per annum in 1928. These funds are being used in straightening, extending and paving the city's thoroughfares.

KEY MAP LOCATING PRINCIPAL TRUNK HIGHWAYS AND BOULEVARDS

Preliminary work had been done on the improvement of outlets toward the peninsula before the passage of the recent bond issues, and as soon as the money was available the way was clear for an immediate start. Three new trunk highways down the peninsula to the south are now planned or are under construction:

1. The projected Ocean Shore Highway, 76 miles long, extending from the Junipero Serra boulevard, will cross the Skyline boulevard and follow down the coast line to Santa Cruz, largely along the right-of-way of the defunct Ocean Shore Railway. This highway, which will be 40 ft. wide on a 100-ft. right-of-way, is being handled by Joint Highway District 9 of the State of California, consisting of San Francisco, San Mateo and Santa Cruz counties. The preliminary estimate of cost is $5,300,000, of which 55, 30 and 15 per cent will be contributed respectively by each of the three counties.

2. The Junipero Serra boulevard is being extended southerly from the county line as an independent highway through the formation of Joint Highway District 10, of which San Francisco contrib-

A 52-FT. CUT NEAR COUNTY LINE
Even with deep cuts, ruling grades of 8 per cent were necessary. Radii on curves were kept above 500 ft.

BOULEVARD PROJECTS NOW BEING BUILT BY BOND ISSUE

	Estimated Cost (Bond Issue)	Length, Miles	Character	Right-of-Way Width, Ft.	Paved Width, Ft., Present Project	Sidewalks	Remarks
1. Bay Shore Blvd.	$2,265,000	3.01	Outlet trunk	125	100	Two, 12½ ft. each	To be extended through San Mateo Co.
2. Alemany Blvd.	2,365,000	4.80	Connects 1 and 3	100	80	Two, 10 ft. each	Occupies old R.R. right-of-way
3. Junipero Serra blvd.	850,000	1.80	Outlet trunk	125	100	Two, 12½ ft. each	To be extended into San Mateo Co.
4. 19th Ave. extension	500,000	1.25	Secondary outlet	100	80 to 88	Two, 10 ft. each	Extension. Uses municipal right-of-way
5. Sunset blvd.	1,900,000	2.10	Cross-connection	240	Two 50-ft. roadways	Two, 10 ft. each	Bridle paths and planted strips
6. Ocean Beach esplanade	475,000	0.45	Shore drive	250	188	Two, 20 ft. each	Extension. Includes seawall
7. Great Highway	525,000	2.05	Extension of No. 6	300	Two 50-ft. roadways	Boardwalk Sidewalk, 10 to 15 ft.	Bridle paths and planted strips
8. Van Ness Ave. extension	500,000	0.16	Extension	125	93	Two, 16 ft. each	.....
9. Bernal cut	1,400,000*	0.81	Outlet trunk	...	42	Three, 8 ft. each	Provision for steam and electric RRs.
	$10,780,000	16.43					

*Voted June, 1927. All others voted Nov. 8, 1927.

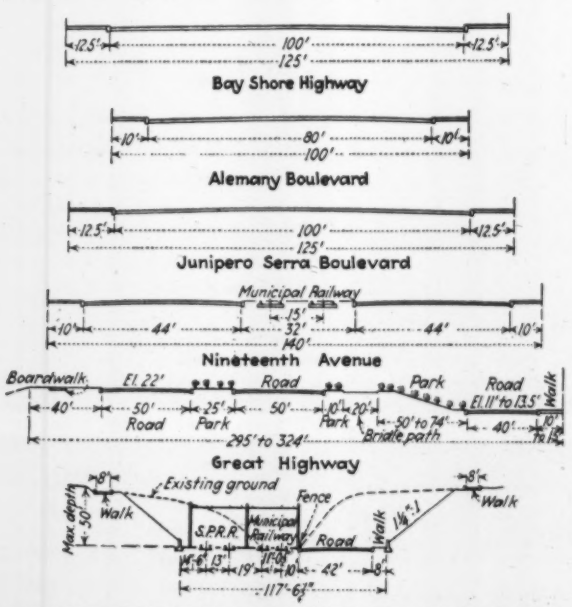
utes 85 per cent and San Mateo County 15 per cent of the cost.

3. The Bay Shore Highway now under construction by both city and state will provide a broad, low-level artery to Santa Clara County.

Bernal cut, now under construction with funds from a previous bond issue, is primarily an outlet to highways leading down the peninsula. By cutting through a hill that has been a barrier to north and south traffic, it will open an outlet from other streets to Alemany boulevard.

This project is novel in that an agreement has been made with the Southern Pacific railroad whereby the cut will be wide enough to take care of a double-track standard-gage railway as well as a double-track line of the municipal electric railway in addition to the 42-ft. vehicular roadway. The cut will have a maximum depth of 52 ft., will be 117½ ft. wide at the base and will have side slopes of 1¼ to 1. A 4-ft. masonry wall will be built to hold the toe of each slope, and three 8-ft. sidewalks will be provided, one in the cut and two at the tops of the slopes. Two streets will be carried across the cut on concrete bridges and a third grade separation will be made where Bosworth St. passes beneath the new boulevard.

The city's policy on all boulevard construction is to lay permanent paving immediately wherever the subgrade is in satisfactory condition. On fills or ground subject to settlement a a temporary oiled gravel pavement is used consisting of an 8-in. macadam base bound with oil and finished off at an elevation such that it will serve as a base for the concrete pavement.



TYPICAL CROSS-SECTIONS OF THE NEW BOULEVARDS

All of the boulevard projects, with one exception, will have concrete pavement 8 in. thick surmounted by 1½ in. of asphaltic binder and a 1½-in. asphalt concrete wearing surface. The standard concrete mix is one part of cement to approximately five and one-half parts aggregate, the aggregate being made up of coarse graded sand and ¼-in. to 2½-in. gravel or crushed rock, the quantity ratio of fine to coarse being 1 to 2. Specifications require six sacks of cement per cubic yard of concrete, watered to give a 1½-in. slump.

All concrete that is to be hand finished is poured in 10-ft. strips, but where mechanical tampers are used the contractor has the option of making the strips 20 ft. wide. Dummy joints, ¼ in. wide and 2 in. deep, spaced 25 ft. apart, are placed in the pavement and are filled with asphalt to within ½ in. of the surface.

On the earlier work concrete bases were cured in the usual way with impounded water. Recently experiments have been made with an asphalt spray coat using a patented compound to hasten curing. Thus far laboratory tests of samples of the pavement already laid indicate that this method will give the concrete a strength of 3,000 lb. in seven days and about 4,200 lb. in 28 days. All concrete base is sprayed with a thin coat of asphaltic cement prior to placing the binder, which is composed of the following ingredients expressed in proportions by weight: Asphaltic cement, 4 to 6 per cent; stone dust, 4 to 6 per cent; sand, 20 to 35 per cent; coarse aggregate, 72 to 53 per cent.

The asphaltic concrete wearing surface consists of the following proportions, by weight: Asphaltic cement, 6 to 8 per cent; mineral aggregate, consisting of broken stone or gravel, sand and stone dust, 94 to 92 per cent.

Both binder and wearing surface are spread with a mechanical spreader to which a raking device is attached. Rolling is done first with a three-wheeled, 12-ton roller, followed by an 8-ton tandem roller. Requirements for uniformity of surface are that variations from true grade and cross-section of the finished surface may not exceed more than ¼ in. in any 10 ft.

The only exception to this type of paving is the Great Highway, a drive along the ocean shore, which will be used almost entirely by pleasure vehicles. Here the pavement consists of a 10-in. macadam base with a 2-in. asphaltic concrete wearing surface.

A total of fourteen pedestrian subways is being built in connection with the various boulevard projects now under way. These have a standard cross-section of 6x7 ft., although at one busy intersection the cross-section is made 8x12 ft. and there is one equestrian subway with an 11x15-ft. section.

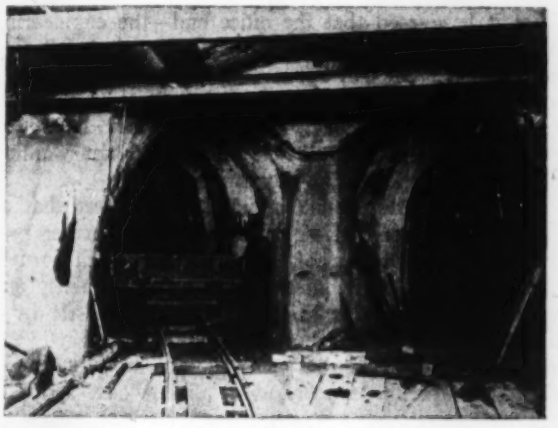
Conduits for lighting standards and traffic signals, together with all underground work involved in projected utility development, is done in advance of boulevard paving to avoid opening up the pavement for some time.

Progress on Hetch Hetchy Water Supply Tunnels

Last Foothill Section Holes Through—Lining Now Under Way—Coast Range Tunnels 29 Miles Long Well Started

A FOUR-MILE section on the 16.7-mile Foothill division of the Hetch Hetchy aqueduct in California was holed through on Dec. 6, thereby finishing tunnel driving in that division. Concrete lining was begun in parts of this division some time ago and now can be carried on throughout all of that portion (about 45 per cent) of the 16-mile stretch that is to be lined. In the Coast Range division, where construction has been begun on a 28.6-mile length of tunnel, about 500 men are employed, working out of seven camps. Of the five shafts that will be used in driving that division of the aqueduct, all have been put down to tunnel grade, and from three of them headings are now being advanced in both directions. Tunneling also has been commenced from two of the four portals of the Coast Range division. A general résumé of construction work on the Hetch Hetchy tunnels appeared in *Engineering News-Record*, April 19, 1928, p. 614.

Completion of tunnel driving on the Foothill division marks the end of work begun in February, 1926, and carried on partly by the city forces and partly under contract. As the work has neared its close men and



CROSS-CUT HEADING DRIVEN FROM INDIAN CREEK SHAFT
Junction connecting cross-cut from the shaft with the two main headings.

equipment have been moved to the Coast Range tunnels, which have been opened up on an extensive basis during the past year.

Progress on the Foothill tunnels often was hampered by considerable water, as much as 500 g.p.m. coming into some of the headings at times through a single drill hole. Water was encountered under pressures of as much as 350 to 400 lb. per sq.in., and in grouting the flowing seams air pressures up to 625 lb. were used. In general, water was grouted off immediately on being encountered. This several times caused delays of from one to four or five days in tunnel excavation, but permanently eliminated the necessity for handling the water. Another reason for prompt grouting was that the tunnel passes through arid territory and it was necessary to take every precaution to avoid draining surface springs.

In the 4-mile section just completed, the center lines of the two headings as checked up on holing through were found to be 0.45 ft. apart. The grades checked to 0.04 ft. Contractors on the Foothill division were A. Guthrie & Company and Connolly & DeLuca.

On the Coast Range tunnel all the camps are being operated by city forces and it is not the plan to take any bids for contract until all headings have been well opened up and the character of the ground has been established.

The Coast Range tunnel runs on a practically east and west line, beginning at Tesla portal, on the east side of the San Joaquin Valley, and passing about 7 miles south of Livermore and Pleasanton to a western portal on the San Francisco Bay slope 2 miles east of Irvington. In

CAMP AT MOCHO SHAFT, COAST RANGE DIVISION
This shaft, 818 ft. deep, is at one end of one of the 5-mile tunnels.

this total distance of 29.2 miles the entire length is tunnel except a 0.6-mile siphon across Alameda Creek near the western end. In addition to the east and west portals, two portals will be opened up in Alameda Creek and ten other headings will be driven from the five shafts.

Two of these shafts are about 760 ft. deep to tunnel grade; the three others range from 254 to 322 ft. in depth. Each shaft is sunk to about 55 ft. below tunnel grade, to permit loading the shaft skips with muck from a rock pocket beneath the invert level. The period of construction for the Coast Range division as a whole will be fixed by the time required to complete the two longest stretches of tunnel. These two lengths are each slightly more than 5 miles, this being the maximum distance permissible between shafts, as fixed by the time available for construction and a conservatively estimated rate of progress.

The work is being done under the direction of M. M. O'Shaughnessy, city engineer of San Francisco.

Abbreviations of Engineering Terms

A tentative American standard for abbreviations of scientific and engineering terms has been prepared by a sub-committee of the sectional committee on the standardization of scientific and engineering symbols and abbreviations and has been published to stimulate discussions before the tentative abbreviations are adopted as standard. Copies of the tentative standards may be obtained from C. B. LePage, assistant secretary, American Society of Mechanical Engineers, 29 West 39th St., New York City.

This Material—CONCRETE

An Article in Four Chapters

A Discussion of the Vital Problems of the Concrete Industry, Outlining Certain Obstacles to Consistant Quality Production and Indicating a Line of Progress

By Nathan C. Johnson
Consulting Engineer, New York City

II—Commercial Production of Concrete

In the First Chapter of this article certain obstacles to effective standardization of the art of concrete construction were discussed. The question whether current specifications do actually specify is further examined in the present second chapter. The contrast between laboratory concrete-making and field practice is pictured in trenchant terms. Later there will be derived a simple specification which in effective manner brings laboratory and field into closer accord.

* * *

STANDARDIZATION in any art must be based not only on agreement as of basic or scientific facts but also on agreement as to what tolerances in commercial practice are compatible with the precepts of science and what are incompatible.

Production alone, when in violation of factual knowledge of cause and effect, may not be set up either tacitly or by common consent as standard, without the payment of severe penalties both in values rendered and in destructive confusion. It is only fair and right, therefore, that the commercial production of concrete be studied, both as to accord and as to discord with the science of concrete that has thus far been evolved. Not only the product turned out must be evaluated in this study, but also the means of its production, the circumstances that attend its production and the reference factors and means that assure or are assumed to assure its value.

The Hurly-Burly of Field Work

As we study these means and modes and methods, we find that any sizable concrete structure in the making under modern production schedules is a hurly-burly, for time and money are at stake. Cost is the presiding genius of the operation. Low costs mean speed, for speed means time and time means wages, interest on capital and possibly bonuses or penalties.

On the job, cement is cement, sand is sand, stone is stone, water is water and weather is weather. No time for niceties, no leisure for reflection and, perchance and even possibly, a most wordy flow of language here and there to speed the laggard hand. Men and machines and materials in an unceasing stream are everywhere in evidence, all governed by the plans prepared by the engineer or the architect and, presumptively, by the specifications.

The cause of all this battle is a carrying out of these plans. As was stated in Chapter I, when these drawings were prepared the basic assumption that governed the design of all parts was unit stress in concrete and unit stress in steel as prescribed by code. After this code allowance came factors of safety. That is, the allowed unit stress of, say, 600 lb. in compression for concrete, multiplied by the factor of, let us say, 4, gave an ultimate requirement of 4 × 600, or 2,400 lb. per sq.in. in compression at 28 days as the strength which the concrete must possess.

The Engineer's Attitude

On the basis of some very excellent and careful research work which has been generously made available to the public, it is quite customary nowadays in engineering offices to say that not only *must* the concrete possess that strength but that it *may* and *shall* possess that strength, largely by virtue of substituting in given formulas certain figures derived from sieving analyses of the sand and stone current on that job and thus fixing the quantities of cement, sand, stone and water that shall be used per batch of concrete.

Let it be agreed that the office end—the engineering and designing and prescribing end—has done all that codes and current and approved practice would indicate as desirable. Let it be further agreed that the materials from the job, sent in bag lots to a laboratory, have been tested singly and commingled and found not wanting from the standpoint of 28-day strength.

Let a further step be taken and let it be agreed that, as a further testimony of rightness and as a further precaution and proof thereof, test cylinders, each formed from some 50 lb. of materials, are being regularly and systematically taken from the job concrete itself by a skilled man sent by the laboratory and that these cylinders are being crushed in the sensitive laboratory machines when they are 28 days old, with all due care and precautions.

Making Test Cylinders

According to our reference-authority standard, a standard deriving its authority by being sealed with the approval of a large number of representative men, skilled in the art, this taking of specimens from the actual work must be done as follows and in no other way:

(*a*) The pails or other receptacles containing the samples of concrete shall be taken as quickly as possible to the place (on the job) selected for molding test specimens. To offset segregation of the concrete occurring during transportation, each sample shall be dumped into a non-absorbent, watertight receptacle and, after slight stirring, immediately placed in the mold.

(*b*) The test specimen shall be molded by placing the concrete in the (cylinder) form in layers approximately 4 in. in thickness. Each layer shall be puddled with 25 to 30 strokes with a $\frac{5}{8}$-in. to $\frac{3}{4}$-in. bar, about 2 ft. long, tapered slightly at the lower end. After puddling the top layer, the surface concrete shall be struck off with a trowel and covered with the top cover plate, which will later be used in capping the test specimen.

As we look out over the job, realizing that 300 cu.yd., or 1,134,000 lb., of mixed concrete materials must be put in forms this day, else the contract will be behind schedule, it comes to us that this specification for concrete and making concrete is charming. It brings rest and peace by its very reading. No rough stuff here! No swooping of a yard at a time down a chute, with a drop of from 5 to 20 ft. No teasing or flowing along forms for 50 or 60 ft., no spading back from forms to make a heavy mortar skin or a form surface as may take place out yonder, in the making of commercial sections.

In fact, it comes to us that our good friend the test specimen is so protected and so hedged about with precautions as to manipulation in its form as to insure a very high degree of uniformity in its vitals, so that it cannot but succeed in attaining a high standard at an early age, and *there is no tolerance permitted in the manner of its making.*

In further recognition of this fact, F. R. McMillan, director of research of the Portland Cement Association, says in his "Concrete Primer," now read all over the world:

Question 56: *How does the method of molding affect the test results?*

Answer: Unless the specimens are carefully molded, erratic and irregular results will be obtained. The concrete should be placed in the mold in several layers, rodding each layer before more concrete is introduced. The mold should be held firmly in a vertical position during filling and stand on a base plate that is a true plane. (See A.S.T.M. Standard Methods of Making Compression Tests of Concrete—Serial Designation: C 39-27.)

And in Question 63: *Are there standard methods of making and testing concrete specimens?*

Answer: Yes. A.S.T.M. Standard Method of Making and Storing Specimens of Concrete in the Field (Serial Designation: C 31-27). A.S.T.M. Standard Methods of Making Compression Tests of Concrete (Serial Designation: C 39-27).

These should always be followed where possible. In any case great care should be used in all operations of making and testing.

In this making of test cylinders, be it noted, a maximum compacting of the aggregate is brought about; and a rejection of the laitance or overwet fines from the top is also obligatory. Further paragraphs in these same approved specifications provide, in addition, for its careful handling, its exposure to a uniform temperature only; and last and not least, for its storage in a bed of sand until it is taken up to be squeezed to fragments so that the pressure required to do this may be reported in pounds per square inch, and, it is hoped, to the blessing of all that material that we see going into the forms under far different conditions.

The more we look from cylinder to job and from job to cylinder the more interesting it becomes from the standpoint of standardization and tolerances. The most striking thing is that the concrete in each may be essentially different in composition and in character.

The Cylinder and the Job

The cylinder, because of its restricted section, contains only the smaller sizes of stone, and lots of it; the fines are caused to rise and are scraped off; and the puddling with "a ⅝-in. to ¾-in. bar, about 2 ft. long, tapered slightly at the end" during molding has brought about all the loose water up to the top, where it can be and is struck off with the fines. And furthermore, it is only a bit of human nature that the skilled operative, who makes the test specimens, should do his level best to make the cylinder as perfectly as is possible.

The job, on the other hand, sedulously retains every bit of the water and of the fines, even though these fines be "clay or other unsuitable materials" according to this same reference standard. Furthermore, on the job but not in the cylinder the depth of this risen water increases and the depth of the washouts or fines as well, so long as the placement of the concrete continues, until these risen materials reach the lift height determined on; and they are then most decidedly not struck off or removed, for they sell at a high price as they stand. *The tolerance on the job is almost without limit.*

Practical Conditions

It is therefore incumbent upon us to determine whether we are testing one thing and furnishing another, by almost common consent, or whether we are not. We must also determine whether these procedures open the way for abuses beyond the limit of reasonable tolerances or whether they do not.

Before turning to investigation and to common sense for the adjudication of this matter it may be well to say that nearly all observers agree that *much excellent concrete is made, and some very bad concrete.* It will advance matters considerably toward a better understanding if it is further agreed that all of the bad concrete is not made by the poorly financed, the underequipped or the smaller contractor. In the matter of good and bad work, the larger organizations, where direct contact and personal supervision are difficult, often operate under a handicap.

And this is natural, for while the more dependent constructor feels that he personally must make good, the sub-men of the larger feel that the firm they work for has made good; that its financial and other resources prove it; that they or their firm "have put in five million yards of perfect concrete and their experience is such," and so on and so on. It is quite comprehensible that the big contractor's employees should feel the weight and value and power of these resources; and it is further comprehensible that this feeling may grow until it reaches a point such that, whatever they do, either by accident or otherwise and whether good or bad, they may and can and possibly will point out that it is all, let us say, an "Excalibur Company job."

The potency of these things either in an objectionable or in an amicable effort to change specifications to suit "the Excalibur Standard System," whatever that may be, is all too well known to need any extensive comment at this time.

A Contractor and His Job

But let us suppose that "Excalibur Company," a corporation neither large nor small, is an existing entity rather than a fiction. Let us suppose that this company is working under the clauses of a recent and quite good specification drawn by an engineer of high repute, which reads, in actuality, as follows:

Class A concrete shall have a compressive strength of 2,600 lb. per sq.in. at 28 days, and Class B concrete shall have a compressive strength of 2,400 lb. per sq.in. at 28 days. The contractor may change the plasticity or slump of the concrete upon notifying the engineer of his intention to do so, provided that he shall maintain constant the same water-cement ratio by volume as is required to produce

the desired strengths. Additional compensation shall not be allowed for such changes.

The acceptance or rejection of all concrete placed under this contract shall be based on the average compressive strengths in pounds per square inch at 28 days of three to five cylinders made and tested in accordance with the current "Standard Methods of Making and Storing Specimens of Concrete in the Field."

Two things are primarily in evidence in this specification. The first is that cylinder tests at 28 days shall determine "the acceptance or rejection of all concrete placed under the contract." The second is that there are evidences of sincere attempts at field regulation by references to the water-cement ratio and to the slump test.

Duff Abrams' Work

And at this point the writer desires to pay sincere tribute to the clever and patient work of Duff Abrams, which eventuated in his deductions of the relation between water content and cement content and strength in a concrete, now known all over the world as the "water-cement ratio." This work deserves high credit, and not least because it appeals to all alike in a simple, understandable form and demonstrates the evils of excess water in a most salutary way. And thanks also should be rendered to the cement makers and their association both for providing the finances that made this research possible and for providing such widespread publicity that even the most remote users of cement have been forced to give heed.

But in carrying out the contract and the foregoing extracts from the specifications, let us say that the Excalibur Company has undertaken a big-scale and a difficult operation. Fundamentally, the Excalibur thoughts and the Excalibur efforts are centered on high production and least costs, for that is the procedure by which the Excalibur financial standing has been achieved.

The Excalibur super knows this and the Excalibur foremen know it, and so do all the Excalibur laborers down to the last man wearing an Excalibur button in his hat. It is for achieving the one fundamental purpose of low cost and fat profits that all the machinery, all the men and all the stockpiles of materials have been assembled and all the money thrown into this venture.

It may quite possibly be that all the work done is most excellent—even perfect, let us say. If it is perfect, so much the better. But as not all work is perfect as a usual thing, and as it is the less perfect work that is of primary concern in this and in any investigation, let us assume for argument that some section of the whole has met with misfortune of one kind or another during placement.

So it may chance, when forms are removed from this assumed section, that a none-too-pretty picture of honeycomb and of laitance are presented to the eye, because high production has demanded haste even under adverse conditions, such as a storm.

The Hard-Boiled Engineer

The owner's engineer or architect may spot this defective work and seek out the Excalibur superintendent. Let us suppose, just for instance, that the engineer is one of those who are variously known as "bearcats," "theoretical but not practical" or "academic" personages, and that he came to the job with a curious literalness in his make-up that causes him to refer repeatedly to specifications.

Shall he order the visibly poor ripped out and replaced? If he does, "delays, extras and damages" is the cry. If he does not, the alternative is smearing it over on the outside, like a bad boy hiding a stolen apple.

But since this man lives by the specifications, he may also be willing to die by the specifications. This engineer may, indeed, be so rigid that he is commonly said by the Excalibur men to have canine ancestry on the distaff side; and he may, in a thousand things, such as rejection of materials, fussiness about forms, insistence on exact placement of steel and so on, fairly win this accolade from the standpoint of production and least work.

But when this mass difficulty comes up, the specifications say, in type that now looks a foot high:

THE ACCEPTANCE OR REJECTION OF ALL CONCRETE PLACED UNDER THIS CONTRACT SHALL BE BASED ON THE AVERAGE COMPRESSIVE STRENGTHS IN POUNDS PER SQUARE INCH AT 28 DAYS OF THREE TO FIVE CYLINDERS MADE AND TESTED. . . IN ACCORDANCE WITH THE CURRENT "STANDARD METHODS OF MAKING AND STORING SPECIMENS OF CONCRETE IN THE FIELD."

These jury-specimens have been made by standard methods and stored in standard ways three days ago. In 25 days more they can be broken in a testing machine. But in the meantime: May and can the job be held up without, in fact, penalties for "delay, extras and damages" being most justly exacted?

Although it is probably as much as most men's jobs are worth to insist on waiting for this approval from test cylinders at 28 days, let us assume that this engineer is so "fine haired" or so foolishly brave as to do so. Grant that he rejects the customary smear-over and stops the work or orders it blasted out—what a dog fight!

The Strength Standard

But since we have this test-specimen standard and since this standard is invoked, it may as well be granted beforehand that the evidence of test cylinders will be all in favor of the reliability of the construction and of its perfection for the reasons before cited in the first portion of this article. Furthermore, if cores were hastily taken as further proof in an effort to lift the engineer's embargo, the chances are that the testing of these cores will be of an apparently convincing nature, for the part of the core chosen for test will most likely be of that portion of the body of the concrete penetrated by the drill which will have the greatest solidity, if for no other reason than that the weaker portions will have disappeared through being ground to powder during the drilling operation and evacuated in the wash water. Also, it is only human nature to choose the best; and the innate desire of every engineer to be fair will cause him to reject the visibly poor and weak in favor of the better. And even if these tested cores prove only to be of, let us say, 1,000 lb. strength, the laboratory or the method of test will be averred in error, rather than admission being made that the structure itself is poor *in even a single spot.*

In this whole situation the contractor, if a man of experience and record, has every strategic advantage in his favor. He knows, for instance, that the visibly bad work physically may not be ripped out and successfully replaced, for the old and the new will never bond together. He may and probably will refer to certain standing-up constructions, executed either by himself or by others, where equal liberties were taken. He certainly will refer to "the reputation, standing and knowl-

edge of our organization" and to the surety bond as guaranteeing quality and safety, and demand that permission be given to proceed.

Doubts About the Laboratory

Nor is this exaggeration. We not only have this situation with us, but have it with us so often that it is now proposed that there shall be established a national institution where laboratory results shall be reviewed with the intent of fixing *wherein the testing laboratory deviated from proper procedures!* It would seem that occasions such as outlined above have transcended allowable tolerances and that blaming the laboratory, where the greatest of care is exercised as contrasted with the job, might go far in destroying faith in our established standards.

But to take another aspect, let us assume that for one reason or another all these tests are caused to appear equally satisfactory from a strength standpoint on concretes taken from the very sections that apparently are bad to the eye as well as from those that are apparently good.

What is the engineer to do against this demonstration, even though his better sense and innate judgment convince him that he is getting a job far below his reasonable expectations? If the contractor is ordered to comply strictly with specifications, which quite often require the removal of defective sections, and raises a counter-cry of delay, extras, loss, damages and so on, it is dollars to doughnuts that the architect or the engineer plus the owner will give way—and in large measure by force of those test specimens. In one instance of a leaky reservoir wall, 8 ft. in thickness, an expert was called in to testify that the holes-through were "superficial and of no moment." And he got away with it.

Granting that all these things are unintended perversions of a test that is really good in its own sphere, none the less something is wrong in this picture that is presented so many times a day to so many people. The test specimen may be omitted, but unless there is brought about a better standardization than we yet have, the do-as-we-please or "practical" procedure can go on in spite of specifications, for in almost all cases the structure will bear its load, even though it be made up from alternations of honeycomb and of laitance or of laitance and good concrete. Even laitance will stand up under loads permitted by code.

Service Results

The foregoing is as of an unidentified construction, but it is repeated daily on thousands of identified and identifiable constructions. When defective portions as noted above are exposed to the influence of water, as in dams, reservoirs, dry docks and a thousand and one other constructions designed either to keep water out or to keep it in, the integrity of such a construction may be in question, if the bad section is in a critical spot.

If a careless construction of this kind is in a so-called "dry exposure," as in a building, but subject none the less to atmospheric tides of alternately excessive and diminishing moisture, the trouble experienced will be longer in making itself evident, but it will become evident. In severity it will vary from surface blotchings to really severe softenings.

The usual smearing-over, however, is greatly loved. The smear is never permanent. It rarely is sightly beyond a few weeks. But it is deeply loved because, in the current phrase, "it gives us all the breaks." And "us," by the way, is not the contractor alone; "us" is essentially everybody who had any part or hand whatever in that construction.

Think it over. Think it over well, for the commercial and the engineering absurdity in this situation is of such importance that the engineer, the architect and the laboratory scientist must either throw up their hands and give way to the unskilled laborer, or else their art as established, as accepted and as promulgated in untold reams of printed matter must be modified in some manner such that the tolerances permissible may be stated so definitely that the constructor may know beforehand, without quibble or hope of quibble, just what is required.

Some Matters to Remember

Nobody loves the smear-finish in reality. It has grown up and become sanctioned because no one has known what else to do.

Of it might be truly quoted:

> That to be hated, needs but to be seen.
> But seen too oft, familiar with its face,
> We first endure, then pity, then embrace.

Fortunately, however, it is not difficult to make very good and even highly excellent concrete. The test specimen may not be used and need not in connection with such work. But the lessons taught by the specification for making test specimens that are so excellent in character should be kept with us and should be applied, in essence, in the field.

Puddling is one lesson. Even depositing is another. Continuous depositing to the top of a form is a third. And last, but by no means least, plenty of stone, clear to the top, should not be forgotten, for stone, if not in too large fragments, is the best and most enduring material that is used in concrete and is capable of serving us in the greatest variety of ways.

It is a pleasure to note the production of uniform concrete in increasing measure. It is unquestionable that uniform concrete can be and is being obtained in field structures on a large scale and even more economically than the slattern-method stuff that all too often gets by for the sole reason that any mixture containing our generally excellent modern portland cements will always fill forms, always harden and (by reason of the low unit-stresses of our design) will always carry the load and even many times the load that our designers are wont to put on it.

* * *

Should we throw overboard the strength-test specimen? By no means. But equally, *strength should not be a sole standard*. It is misuse of what the test specimen really shows and really has within it that has derogated the using of concrete and made its production an empirical procedure rather than a regulated art; and it is this same misuse that has brought about a gross abuse of proper tolerances which should not be permitted or glossed over.

And, perhaps even worse, shutting our eyes to what really lies beyond the cracking of a test specimen has done more to stifle the use and the proper utilities of concrete than any other one thing.

Strength alone is mere dogma. How that strength comes about is science; and this science when applied can become art and susceptible of economic standardization, as will be shown in subsequent chapters of this series.

The third chapter of Mr. Johnson's article will appear Feb. 14.

Absorption of Wood Preservatives

Specifications Most Satisfactory When Based on the Dimensions of the Timber and Should Take Into Consideration the Variability Likely to Result From Different Lengths and Cross-Sectional Areas

By J. D. MacLean

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PRESENT practice in the wood-preserving industry is to base specifications for preservative treatment on the net retention of preservative per cubic foot of wood. In general, the absorptions specified on this basis for widely varying sizes of lumber and timber are practically the same as those commonly used for crossties, despite the fact that material of different sizes may have widely different ratios of surface area to volume on account of varying cross-section dimensions. This practice, of course, would be logical if the entire volume of the wood were treated. Experience in the impregnation of wood with either water solutions or preservative oils, however, has shown that most timbers of structural sizes, which contain heartwood, cannot be completely penetrated even by the most effective methods of treatment; if treated timber is cut in two an untreated area of considerable size will usually be found beneath the outer treated area.

At times in the past attention has been directed to the fact that timbers differing either in size or in shape or in both receive different penetrations for a given absorption per unit of volume. [See Lowry Smith, "Penetration of Preservatives," *Wood Preserving*, Vol. 3, No. 3 (1916), and R. H. Rawson, "Penetration of Creosote in Various Sizes of Sawed Lumber and Round Piling," American Wood Preservers' Association *Proceedings* (1920).] A simple illustration is a comparison of a cube of wood 12x12x12 in. in dimensions with a piece 3x12x48 in. The two volumes are equal, but the surface area of the cube is 6 sq.ft., whereas that of the 3x12x48-in. piece is 10.5 sq.ft., or 75 per cent more.

Some specifications, based on a fixed absorption per unit of volume, have required a heavy absorption in large-dimension timbers and have permitted correspondingly smaller absorptions in small-dimension material. This situation has resulted in difficulty in obtaining the specified amount in the big timbers, while the small sizes have had very unsatisfactory penetrations.

A recently adopted specification, which will illustrate the disparity in results that may occur under the conditions just outlined, requires for general construction an empty-cell treatment, giving a net absorption of not less than 12 lb. of creosote per cubic foot in the sizes of Southern pine timber designated. Table I lists practically all of the sizes. With an empty-cell treatment the gross absorption naturally is considerably higher than the net absorption and the depth of penetration is necessarily greater than it would be if the air space in the treated part were left completely filled with the preservative when the treatment was finished. For the purpose of showing the variability in penetration that may be obtained in the different sizes of timber named, however, it is sufficient to show the average depth of side penetration required if the net absorption is 12 lb. per cubic foot, assuming that the air space is completely filled with the preservative. The following average values of specific gravity, moisture content and ratio of end to side penetration, which are based on data from experiments, will be assumed for the wood:

Oven-dry weight; 36 lb. per cubic foot. Moisture content at time of treatment, 20 per cent, or 7.2 lb. of water per cubic foot. Average end penetration, twelve times the average depth of side penetration. Specific gravity of creosote at treating temperature, 1.03.

Since the specific gravity of actual wood substance is about 1.5 for all species, the amount of air space in a cubic foot of wood is readily computed when the weight and moisture content are known. With the preceding values the results shown in Table I are obtained for the structural material listed.

A comparison of the penetrations for the different timbers, recorded in Table I, indicates that with the same volumetric absorption the depth of penetration may vary several hundred per cent for the range of sizes given. Similar variations in penetration may result when equal volumetric absorptions are used in round timbers, such as posts, poles and piling, of different diameters. Since an empty-cell treatment does not permit the air spaces to be completely filled, the penetrations shown in Table I are appreciably lower than the 12 lb. per cubic foot absorption would actually give with the empty-cell process. Regardless of whether the penetrations would be proportionally increased by empty-cell treatment, however, the data clearly show that using an absorption

Abstract of a paper presented at the convention of the American Wood Preservers' Association at Louisville, Ky., Jan. 22-24.

TABLE I—DEPTH OF PENETRATION REQUIRED IN VARIOUS SIZES OF SOUTHERN PINE TIMBER TO OBTAIN A NET ABSORPTION OF 12 LB. PER CUBIC FOOT, FULL-CELL TREATMENT*

Kind of Timber	Cross-section Dimensions of Pieces, In.	Length of Pieces, Ft.	Volume of Pieces, Cu.Ft.	Total Absorption in Timber, Lb.	Volume of Wood Impregnated, Cu.Ft.	Approximate Depth of Side Penetration Assuming Air Space in Treated Portion Is Completely Filled, In.
Caps	10x12	22.0	18.32	220.0	6.85	0.95
Stringers	6x14	20.0	11.67	140.0	4.36	0.75
Swaybraces	3x10	24.0	5.00	60.0	1.87	0.43
Bulkhead	3x10	20.0	4.16	50.0	1.56	0.43
Wheel or felloe guard	4x 6	20.0	3.33	40.0	1.25	0.45
Rail post	4x 6	5.0	0.83	10.0	0.31	0.35
Scupper blocks	3x 6	1.0	0.12	1.2	0.04	0.12
Cleats	4x14	4.0	1.56	18.7	0.58	0.37
Bridging between stringers	2x 4	1.6	0.09	1.1	0.03	0.14
Flooring	2x 4	22.0	1.22	14.7	0.46	0.26

*Longitudinal penetration is assumed to be 12 times the average depth of side penetration.

TABLE II—RATIO OF LONGITUDINAL PENETRATION OF PRESERVATIVE TO SIDE PENETRATION OBSERVED IN HEARTWOOD OF SEVERAL SPECIES

(Averages of results obtained under various methods of treatment)

Species of Wood	Preservative	Ratio of Longitudinal Penetration to Side Penetration (General Range of Variation)
Southern pine	Coal-tar creosote	5 to 18
	Zinc chloride	7 to 25
Coast Douglas fir	Coal-tar creosote	15 to 22
	Zinc chloride	15 to 33
Eastern hemlock	Coal-tar creosote	14 to 20
	Zinc chloride	15 to 26
Yellow birch	Coal-tar creosote	12 to 18
	Zinc chloride	15 to 20
Rocky Mountain Douglas fir	Coal-tar creosote	25 to 35
	Zinc chloride	28 to 48

based on pounds per cubic foot necessarily gives results varying widely in the different sizes.

Another important consideration is the fact that the heartwood of most species will take only a limited penetration and it would be very difficult if not impossible to obtain a 12-lb. net absorption in the larger sizes of timber with the process specified if the material were largely heartwood. If the various sizes were treated in the same charge, it is evident that the smaller sizes would receive heavier absorptions than those specified and the larger timbers would not have the required amount, although the average requirement could easily be met.

Obviously there is need of some method of taking into account differences in surface area so that specified absorptions will insure more nearly uniform results in the treatment of variable sizes of timber. The purpose of this paper is to suggest a convenient means of determining within reasonable limits the proportional volumetric absorption required in timbers of varying dimensions to obtain a treatment equivalent to that in a given timber taken as a standard.

TABLE III—AMOUNT BY WHICH VOLUMETRIC ABSORPTIONS IN VARIOUS SIZES OF TIMBER SHOULD BE INCREASED OR DECREASED TO GIVE A TREATMENT EQUIVALENT TO THAT OBTAINED WITH A GIVEN ABSORPTION IN A 7 x 9-IN. x 8-FT. TIMBER

(For heartwood timbers or those which contain only a small amount of sapwood)

Nominal Cross-Section Dimensions, Inches	Length, Feet	Increase or Decrease in Absorption* for Preservative Oils (Unit End Absorption 15 Times Unit Side Absorption), Per Cent	Increase or Decrease in Absorption* for Water Solutions (Unit End Absorption 20 Times Unit Side Absorption), Per Cent
2 x 4	All lengths†	+74	+56
2 x 6	All lengths†	+64	+48
2 x 8	All lengths†	+58	+42
2 x 12	All lengths†	+51	+36
3 x 6	8	+49	+41
	16	+37	+27
3 x 10	8	+38	+33
	16	+25	+17
4 x 4	8	+47	+40
	16	+35	+25
4 x 8	8	+26	+21
	16	+11	+ 4
4 x 12	8	+18	+15
	16	+ 3	— 3
6 x 8	8	+ 8	+ 7
	16	— 8	—12
6 x 12	8	0	0
	16	—17	—20
6 x 16	8	— 5	— 4
	16	—22	—24
8 x 8	8	— 1	0
	16	—18	—21
8 x 12	8	—10	— 8
	16	—27	—29
8 x 16	8	—14	—12
	16	—32	—33
10 x 12	8	—15	—12
	16	—33	—34
10 x 16	8	—19	—16
	16	—38	—38
12 x 14	8	—21	—18
	16	—40	—40
14 x 14	8	—24	—20
	16	—42	—43
16 x 16	8	—28	—23
	16	—47	—46

*+ Indicates increase; — indicates decrease.

†End absorption in timbers 2 in. thick is of so little importance that it was disregarded in these sizes.

Sawed Timbers, Chiefly Heartwood—The most extensive service test records have been obtained from crossties, and the necessary volumetric absorptions for timbers of tie size have been fairly well determined from experience. For this reason a 7x9-in. x 8-ft. crosstie has been taken as a standard for the comparison of absorptions in timbers of other dimensions. For practical purposes the relative absorption in the side and the end surfaces may be assumed as about proportional to the depth of penetration in the respective directions. The following discussion will apply to treatment by either the full-cell or the empty-cell process.

If the average ratio of end to side penetration were known, it would be convenient to obtain what might be called an "equivalent" side surface area on which to base computations. To illustrate (see Fig. 1), let the average

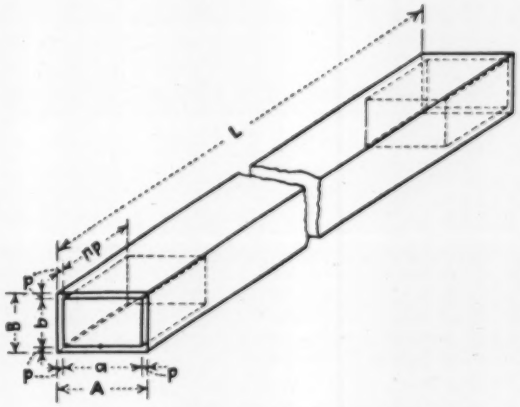


FIG. 1—COMPUTATION OF PENETRATION OF PRESERVATIVE

p = average depth of side penetration.
np = average depth of end penetration.
$2ab$ = area impregnated by end absorption.
$2AL + 2bL$ = area impregnated by side absorption.

end penetration be n times as deep as the average side penetration p. The amount of preservative required to impregnate 1 sq.ft. of end area would then be the quantity needed to impregnate n sq.ft. of side surface area. From Fig. 1 it is evident that the total area to be impregnated in a given sawed timber is equivalent to $2AL + 2bL + 2nab$ sq.ft. of side surface area (when the linear dimensions are in feet).

The average side and longitudinal penetrations obtained in several species have been measured in a large number of air-seasoned heartwood specimens treated at the U. S. Forest Products Laboratory. Table II shows the ordinary range found for the ratio of end to side penetration in five of these woods. With the exception of Rocky Mountain Douglas fir, which is unusually resistant to treatment, the longitudinal penetration of creosote was usually from about ten to twenty times as deep as the side penetration and from fifteen to twenty-five times as deep when the preservative was zinc chloride. A fair average ratio for general conditions would probably be about 15 to 1 for preservative oils and about 20 to 1 for water solutions; these ratios have been used in the following discussion.

To be exact, the area treated from the ends should be taken as the total end area less the average area penetrated by side absorption. Since the depth of side penetration is more or less variable, however, depending on the species, method of treatment and other factors, an average value must be taken. It has therefore been assumed in the computations that the average depth of

side penetration is about ½ in. Numerous measurements indicate that this is a reasonable average value for heartwood timbers impregnated by means of pressure methods. In computing the proportional absorptions, the cross-section dimensions were therefore reduced 1 in. in each direction to determine the average area impregnated by end absorption.

From the ratios of end to side absorptions assumed and allowing for a reduction in end area on account of side absorption as just explained, the "equivalent" side surface area of a 7x9-in. x 8-ft. crosstie is 30 sq.ft. for preservative oils and 33.3 sq.ft. for water solutions. Since the volume of a tie of the dimensions given is about 3.5 cu.ft., a total of 28 lb. of creosote would be required for a treatment of 8 lb. per cubic foot, and based on the "equivalent" area this would amount to about 0.93 lb. per square foot. Similarly, if the tie were treated with ½ lb. of zinc chloride (dry salt) per cubic foot, this would be approximately 0.053 lb. per square foot of equivalent surface area.

Variations in volumetric absorptions of preservative oils required in different sizes and lengths of sawed timbers to secure a treatment comparable to that obtained with a given volumetric absorption in a 7x9-in. x 8-ft. crosstie are shown as percentages in the third column of Table III. The fourth column is similar to the third; the difference is that the ratio of unit end absorption to unit side absorption has been taken as 20 to 1 instead of 15 to 1.

Table IV gives the nominal size, the total side surface area per foot of length, the total end surface area and the volume per foot of length for most of the common sizes of sawed and of round timbers. Except in special cases, the actual crss-sectional dimensions of the sawed material are somewhat less than their respective nominal sizes, but these differences are not important enough to warrant consideration in the computations shown.

While Table III does not include all the cross-sectional dimensions given in Table IV, a sufficient variety of sizes is given so that a close estimate of the required absorption can be made for intermediate sizes. To illustrate the application of the data in Table III, assume that 2x4-in. timbers 16 ft. long are to be given a treatment with a preservative oil equivalent to a 12-lb. treatment in the tie taken as a standard. The table shows that the absorption should be about 174 per cent of that obtained in the tie, or nearly 21 lb. per cubic foot. On the other hand, a 10x12-in. timber of the same length would require only 67 per cent as much as the tie, or a little over 8 lb. per cubic foot.

The foregoing discussion has been taken up from the standpoint of the treatment of heartwood timbers, but since the proportions given in Table III are based on surface area, they should give sufficiently close results for timbers containing both heartwood and sapwood, or for sapwood timbers not completely penetrated. For sapwood timbers in which practically complete penetration is obtained, however, the ratio of surface to volume would not influence the results and, of course, absorptions should then be based directly on the volume and should be the same for all dimensions. In such cases, however, another factor should be considered, for when the whole volume of the stick is penetrated the amount of preservative in a unit volume of treated wood is less than when the same absorption of preservative is concentrated in the outer inch or so. On the other hand, there should always be enough preservative in the treated portion to make the wood thoroughly toxic and to provide a reservoir of surplus preservative to take care of leaching, volatilization and other losses in service.

Round Timbers—The problem of determining the proportional absorptions for round timbers is relatively simple, since in the common lengths the end-surface area is so small a part of the total surface area that the influence of end absorption becomes of little importance. In addition, the deep radial penetration in the sapwood still

TABLE IV—SURFACE AREA AND VOLUME PER FOOT LENGTH OF DIFFERENT SIZES OF TIMBER (NOMINAL DIMENSIONS)

Sawed Timbers — Dimension Sizes					Sawed Timbers — Timber Sizes					Round Timbers			
Nominal Size of Timber (1) Thickness, In.	Width, In.	Total Side Surface Area Per Foot Length (2), Sq.Ft.	Total End Surface Area (Both Ends) (3), Sq.Ft.	Volume Per Foot Length (4), Cu.Ft.	Nominal Size of Timber (1) Thickness, In.	Width, In.	Total Side Surface Area Per Foot Length (2), Sq.Ft.	Total Side Surface Area (Both Ends) (3), Sq.Ft.	Volume Per Foot Length (4), Cu.Ft.	Mean Diameter (1), In.	Total Side Surface Area Per Foot Length (2), Sq.Ft.	Total End Surface Area (Both Ends) (3), Sq.Ft.	Volume Per Foot Length (4), Cu.Ft.
2	4	1.000	0.111	0.056	6	6	2.000	0.500	0.250	4	1.047	0.175	0.087
2	6	1.333	0.167	0.083	6	8	2.333	0.667	0.333	5	1.309	0.273	0.136
2	8	1.667	0.222	0.111	6	10	2.667	0.833	0.417	6	1.571	0.393	0.196
2	10	2.000	0.278	0.139	6	12	3.000	1.000	0.500	7	1.833	0.535	0.267
2	12	2.333	0.333	0.167	6	14	3.333	1.167	0.583	8	2.094	0.698	0.349
..	..	.....	.....	.....	6	16	3.666	1.333	0.667	9	2.356	0.884	0.442
3	4	1.167	0.167	0.083	..	..	.....	.....	.....	10	2.618	1.091	0.545
3	6	1.500	0.250	0.125	8	8	2.667	0.889	0.444	11	2.880	1.320	0.660
3	8	1.833	0.333	0.167	8	10	3.000	1.111	0.556	12	3.142	1.571	0.785
3	10	2.167	0.417	0.208	8	12	3.333	1.333	0.667	13	3.403	1.844	0.922
3	12	2.500	0.500	0.250	8	14	3.667	1.556	0.778	14	3.665	2.138	1.069
..	..	.....	.....	.....	8	16	4.000	1.778	0.889	15	3.927	2.454	1.227
4	4	1.333	0.222	0.111	..	..	.....	.....	.....	16	4.189	2.792	1.396
4	6	1.667	0.333	0.167	10	10	3.333	1.389	0.694	17	4.451	3.152	1.576
4	8	2.000	0.444	0.222	10	12	3.667	1.667	0.833	18	4.712	3.534	1.768
4	10	2.333	0.556	0.278	10	14	4.000	1.944	0.972	19	4.974	3.938	1.969
4	12	2.667	0.667	0.333	10	16	4.333	2.222	1.111	20	5.236	4.363	2.182
Boards and Strips					12	12	4.000	2.000	1.000	21	5.498	4.811	2.405
..	..	.....	.....	.....	12	14	4.333	2.333	1.167	22	5.760	5.280	2.640
1	2	0.500	0.028	0.014	12	16	4.667	2.667	1.333	23	6.021	5.771	2.885
1	3	0.667	0.042	0.021	..	..	.....	.....	.....	24	6.283	6.283	3.142
1	4	0.833	0.056	0.028	14	14	4.667	2.722	1.361	..	.....	.....	.....
1	5	1.000	0.069	0.035	14	16	5.000	3.111	1.555	25	6.545	6.818	3.409
1	6	1.167	0.083	0.042	..	..	.....	.....	.....	26	6.807	7.374	3.687
1	8	1.500	0.111	0.056	16	16	5.333	3.555	1.778	27	7.069	7.952	3.976
1	10	1.833	0.139	0.069	..	..	.....	.....	.....	28	7.330	8.552	4.276
1	12	2.167	0.167	0.083	..	..	.....	.....	.....	29	7.592	9.174	4.587
Tie Sizes Commonly Used					..	..	.....	.....	.....	30	7.854	9.818	4.909
6	6	2.000	0.500	0.250	..	..	.....	.....	.....	..	.....	.....	.....
6	7	2.167	0.583	0.292	..	..	.....	.....	.....	..	.....	.....	.....
6	8	2.333	0.667	0.333	..	..	.....	.....	.....	..	.....	.....	.....
7	7	2.333	0.681	0.340	..	..	.....	.....	.....	..	.....	.....	.....
7	8	2.500	0.778	0.389	..	..	.....	.....	.....	..	.....	.....	.....
7	9	2.667	0.875	0.438	..	..	.....	.....	.....	..	.....	.....	.....
7	10	2.833	0.972	0.486	..	..	.....	.....	.....	..	.....	.....	.....

Note:—The areas given in this table are the actual areas for timbers of the dimensions given and do not take into consideration relations of end to side penetration.

further reduces the volume that must be penetrated from the ends. When the timbers are fairly short and taking end area into consideration consequently is desirable, it can be done very conveniently by assuming that the absorption in the end area is substantially the same as that in an equal amount of circumferential area. Then the total area to be considered for comparing absorptions in timbers of different diameters is the total end area plus the circumferential area; the slight error involved in taking the total end area, instead of subtracting an allowance for side penetration at each end (Fig. 1), tends to compensate for the small inaccuracy in the assumption that absorption through the end surface is no greater than that through the sapwood of the circumferential surface.

By means of the data in the table it is found that the total surface area of the 6-in. diameter post is about 11.4 sq.ft. and the volume 1.37 cu.ft.; these values give about 8.32 sq.ft. of surface area per cubic foot. Similarly, the 10-in. diameter post is found to have about 5.06 sq.ft. of surface area per cubic foot. A comparison of these values shows that the smaller diameter post has about 64 per cent more surface area per cubic foot than the larger post; this is the amount by which the absorption should be increased.

With poles and other long timbers in the round form the end area is generally very small in proportion to the circumferential surface area, so that the latter only need be considered in calculation.

Conclusions

1. Present specifications for the preservative treatment of wood do not give sufficient attention to the variability in results that may occur when timbers of different lengths and different cross-section dimensions are treated in accordance with the specifications.

2. Absorption by volume of timber (pounds per cubic foot) is the most satisfactory and convenient method of specifying treatment provided it is based on a consideration of the ratio of surface area to volume.

3. The ratio of surface area to volume does not need consideration when the timbers are largely sapwood or when an open, porous condition of the wood makes it possible to obtain practically complete penetration.

4. The proportional absorptions calculated by means of Table III are to be understood as guides to help work out the approximately correct absorptions for different classes of material. Very likely it will be found satisfactory, in drawing up specifications, to group several sizes of timber that require approximately the same absorption. The grouping can be conveniently made from a consideration of the proportional absorptions indicated.

Historical Museum at Stevens Institute

A museum of mechanical engineering exhibits was opened at Stevens Institute of Technology, Hoboken, N. J., at the time of the recent inauguration of Dr. Harvey Nathaniel Davis as president of the institute. Included in the museum are railroad relics, high-wheeled bicycles of 1868 to 1880, models of automobiles of a quarter of a century ago, original models of the Hazeltine radio, models of cable sections, of magnetic machines and early generators, of turbines, of aircraft motors, and an Ericsson hot-air pumping machine. Also in one exhibit are models of a blast furnace, a bessemer converter and an open-hearth furnace.

Effect of Temperature on the Strength of Concrete

Tests Throw New Light on Relation of Temperature to Hardening Rate and on the Effect of Freezing at Early Ages

By C. C. Wiley

Assistant Professor, Highway Engineering, University of Illinois, Urbana

THE GROWING practice of placing concrete in cold weather and the insistent demands that the curing periods be reduced to the minimum make it imperative that definite data be secured on the effect of temperature on the strength of concrete in order that trouble may be avoided on the one hand and full advantage of favorable conditions may be taken on the other. That temperature does exert a marked effect on the hardening of portland cement concrete has been recognized for many years, but there appears to be little definite information concerning it.

For the purpose of making a start on temperature investigations, the writer, during 1927, conducted a series of tests on 2x4-in. mortar cylinders. Although the results were highly indicative, it was considered desirable to make a more extensive group of tests on full-size concrete cylinders, basing the procedure on the results gained with the smaller speciments. Accordingly, during 1928, two series of tests were made, one to study the effect of temperature on the hardening rate and the other to study the effect of freezing at early ages.

Effect of Temperature in Hardening Rate—The first series consisted of 90 cylinders, 6x12 in. in size. The nominal proportions were 1 : 2 : 3 but the actual proportioning was done by weight on the basis of 94 lb. per cu.ft. for cement, 103 lb. per cu.ft. for sand and 112 lb. per cu.ft. for gravel, as determined in the laboratory for the materials employed. A nominal water-cement ratio of 0.8, which gave a slump of about 1½ in., was used. The aggregates were artificially dried,

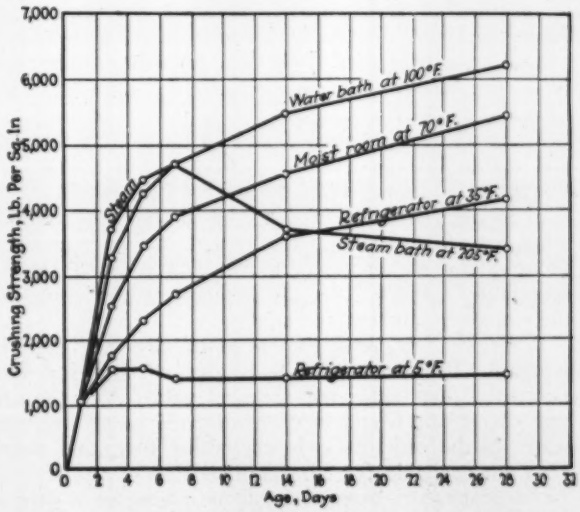


FIG. 1—EFFECT OF TEMPERATURE ON HARDENING OF CONCRETE

The mix was 5¾ : 1 : 2 : 3 (that is, 5¾ gal. of water per sack of cement) by dry rodded volumes. 1½-in. gravel aggregate was used. Time of mix was two minutes. Standard 6x12-in. cylinders were left in forms 24 hours and then cured as shown.

so that allowing for the absorption by aggregates the net water-cement ratio was reduced to an equivalent of about 5¾ gal. of water per sack of cement. The cement was a standard brand of portland cement bought on the open market. The aggregates were commercial products obtained from glacial deposits along the Wabash River. The sand was rather coarse and a little harsh. The gravel was well graded from ¼ to 1½ in.

The mixing was done in a ½-bag power-driven mixer using a mixing time of two minutes. The cylinders were molded in steel forms in the manner prescribed by the American Society for Testing Materials. Enough cylinders were cast to provide at least three for each value desired.

The specimens were removed from the forms at the end of 24 hours and suitable groups stored as follows:

1. In a moist room maintained within 5 deg. of 70 deg. F. and equipped with air-water sprays providing a saturated atmosphere.

2. In a water bath automatically maintained within 2 deg. of 100 deg. F.

3. In a steam bath at atmospheric pressure but with steam flow enough to maintain a temperature between 203 and 208 deg. F.

4. In a meat storage refrigerator maintained between 33 and 38 deg. F. Moisture was supplied as required.

5. In a special refrigerator capable of holding 24 cylinders and provided with an electric refrigerating unit set to maintain a temperature between 3 and 8 deg. F.

With the exception of the frozen specimens the cylinders were taken directly from the storage places to the testing machine. The frozen specimens were first thawed by placing them in the 100 deg. water bath for 1½ to 2 hours. All cylinders were tested while moist in a 200,000-lb. hydraulic testing machine.

The results of this series of tests are shown in Fig. 1. An examination of the data leads to the following conclusions:

1. With temperatures between 35 and 100 deg. F. the hardening of concrete proceeds in the same manner but at different rates.

2. At a temperature of 100 deg. F. the same strength is obtained in approximately one-half the time as at 70 deg. F.

3. At a temperature of 35 deg. something more than twice the time is required to gain the same strength as at 70 deg. F.

4. At all ages between 3 and 28 days, with the mix and materials here used, the difference in strength is practically 30 lb. per sq.in. per degree Fahrenheit.

5. If the curing period is based on the strength when cured at 70 deg., the period can be materially reduced for higher temperatures and must be correspondingly increased for lower temperatures, assuming the concrete to be not frozen.

6. Frozen concrete shows practically no gain in strength. Although these tests give no data for temperatures just under the freezing point, it is thought that the results would be essentially the same, since the water in the concrete is in crystalline form and therefore not available for further hydration of the cement. No dependence whatever should be placed on a gain in strength of concrete while frozen.

7. Curing in saturated steam vapor at high temperatures has a deleterious effect. A slight increase in strength is obtained in the first few days but is followed by a decided retrogression in strength. This phenomenon was found in 1927 with the mortar cylinders and has been observed in tests elsewhere.

One set of cylinders was broken while still frozen at an age of seven days. The strength shown was about 20 per cent greater than that obtained at 28 days with normal curing at 70 deg. F. This fact, combined with the preceding conclusions, offer an explanation of the failure of certain structures built during cold weather and which collapsed when the weather turned warm.

Effect of Freezing at Early Ages—The second series consisted of 75 cylinders similar to those in the first series except that the gravel had a maximum size of about 1 in. and contained a somewhat larger amount of ¼- to ½-in. pebbles. A somewhat larger water-cement ratio was therefore necessary to obtain the same plasticity; hence the mix was substantially 6¼ : 1 : 2 : 3 by dry-rodded volumes.

All of the specifications were left in the forms for 24 hours and then removed to the moist room at 70 deg. F. At ages of one, three, five, seven and ten days suitable groups were placed in the refrigerator at 5 deg. F. for four days. They were then thawed and returned to the moist room. Specimens were broken at intervals of seven days. The numerical results of this series are shown in Fig. 2.

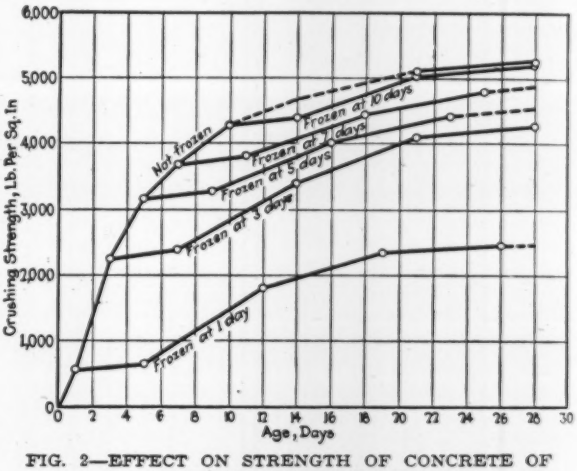


FIG. 2—EFFECT ON STRENGTH OF CONCRETE OF FREEZING AT EARLY AGES

The mix was 6¼ : 1 : 2 : 3 by dry rodded volumes using 1-in. gravel aggregate and mixing for two minutes. 6x12-in. cylinders were removed from forms after 24 hours and stored in moist room at 70 deg. F. except for four days in refrigerator at 5 deg. F., beginning at ages shown.

An examination of the broken cylinders frozen at one day showed a distinct lack of bond between the cement and the aggregate. The pebbles were surrounded with a shell of cement paste showing practically no adhesion to the stone. In many cases there were distinct marks of ice crystals on this cement matrix, indicating that free water had collected around the pebbles and then frozen breaking the bond between cement and stone. Those frozen at three days showed the same characteristics but to a less degree. The marks of ice crystals had practically disappeared in those frozen at five days but the bond was still deficient. The specimens frozen at seven and ten days, so far as could be observed, appeared normal in appearance and behavior. From these results the following conclusions may be reached.

1. Frozen concrete when thawed out again begins to gain strength.

2. Both the rate and the magnitude of the gain in strength depend on the age at which the concrete is frozen, and are materially less for early ages than for later.

3. Concrete frozen before some certain age, which may be termed the critical age, suffers a permanent damage and never gains the full strength capable with the given mix and materials.

4. This critical age is apparently that at which the cement paste has developed sufficient strength and adhesion to the aggregate that free water cannot collect around the rock particles and in freezing break the bond with the cement.

5. For the mix and materials used in these tests the critical age appears to be between seven and ten days. For the mortar cylinders tested in 1927 the critical age appeared to be between five and seven days. The critical age is likely to be longer for leaner mixes and with coarser aggregates because of the smaller amount of cement paste in the leaner mix to gain the requisite strength and adhesion and because the free water appears to collect more readily around the larger particles of aggregate.

6. The strength of concrete frozen at the age of one day is less than half of that of the unfrozen material. That frozen at three to five days has an indicated permanent loss of strength of 15 to 20 per cent. Whether or not there is a permanent damage when frozen at seven days is not clear from these data, but the loss in strength, if any, is small. The curve for the specimens frozen at ten days shows clearly no ultimate loss of strength and also shows distinctly the retarding effect in the gain of strength due to freezing.

Conclusion

As a result of the foregoing tests it is recommended that all concrete should be protected from freezing for at least one week at a temperature of 70 deg. F. or twice as long at a temperature of 35 deg. F. Note that this is a radical departure from the common assumption that it is only necessary to protect concrete from freezing until it has attained final set. This freezing of concrete at an early age with the consequent permanent damage offers an explanation of the failure of certain structures built during cold weather.

It is recognized, of course, that the results here given are far from complete. An enormous amount of work must be done before complete data are available for the full range of mixes and materials. It is believed, however, that these tests are highly significant and that they can be taken as a basis for requiring greater care in protection from freezing and for suiting the curing periods to the temperatures at which work is done.

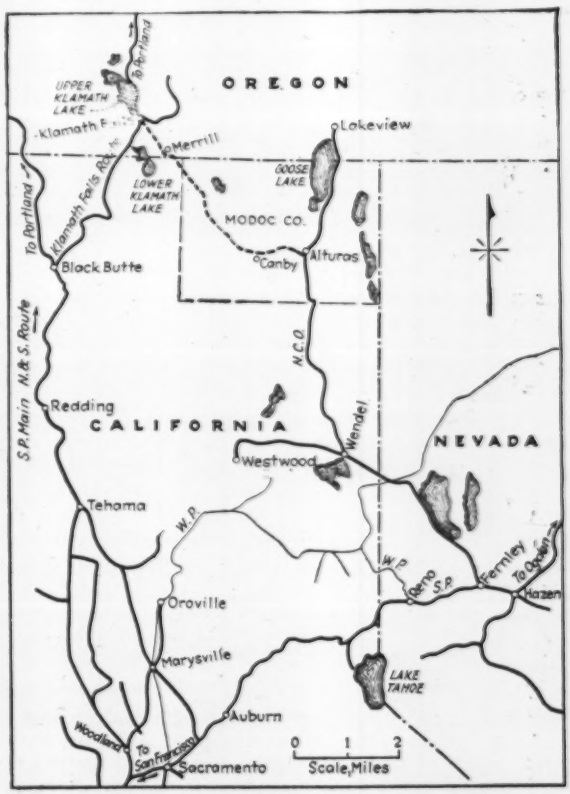
Railroad Builds 95-Mile Line to Open Up Timber Territory

A RAILROAD, 95½ miles long, between Klamath Falls, Ore., and Alturas, Calif., which is now being built by the Southern Pacific Railroad, will provide an outlet for timber to be cut in Modoc national forest and at the same time will complete a new Nevada-Oregon rail route that will shorten by 211 miles the haul from Klamath Falls to Eastern markets. This line constitutes a connecting link between the recently completed Natron cutoff (*Engineering News-Record*, March 5, 1925, p. 388) and the recently broadgaged Nevada-California-Oregon Railroad (*Engineering News-Record*, Feb. 23, 1928, p. 307).

Decision to build this line came about when the Forest Service decided to sell about 400,000,000 ft.b.m. of timber on some 70,000 acres in the Modoc national forest. This decision was due to the ravages of the Western pine beetle, which was causing an annual loss of 10 to 12 per cent in this stand under conditions such that insect control would not be economical. The Pickering Lumber Company, of Kansas City, has bought the timber and is making preparations to build a large sawmill near Alturas.

The Southern Pacific last summer awarded to the Utah Construction Company a contract for the 15 miles of the new railroad between Klamath Falls and Merrill near the Oregon-California line, and in October the remaining distance from Merrill to Alturas was awarded to the same company. The entire line is to be completed by July of this year.

Klamath Falls is at El. 4,102 and Alturas is at El.



MAP SHOWING LOCATION OF NEW RAILROAD IN NORTHERN CALIFORNIA

4,366. Between these terminals northbound traffic will have to climb 1,076 ft. and southbound traffic 1,340 ft., the summit being at El. 4,968 in the head of Howard Gulch. The maximum grade against southbound traffic (the outbound haul) will be 1 per cent, about 20 miles of this grade lying north of the Howard Gulch summit. Northbound traffic will climb 6 miles of 2.2 per cent grade in Howard Gulch to reach the summit. The line will involve no bridges of importance and no tunnels at all.

Mississippi River Flood Control

III—Revetment Construction Plant and Methods

Government Plant Ample to Handle All Construction Contemplated—Plant Units and Their Cost—Possible Improvements in Revetment Structure and Construction—Contraction Works and the Bonnet Carré Spillway

By C. S. Hill
Associate Editor, Engineering News-Record

SECOND in construction importance of the Mississippi flood-control operations are revetment, channel contraction works and the Bonnet Carré spillway. These operations will average nearly $10,000,000 a year for the ten-year period of construction under the present plan. They present a quite different appeal to contractors than does levee construction, considered in the preceding articles.

The outstanding task is revetment construction, and in this discussion only concrete revetment will be given consideration. Willow-fascine mats and board mats (except for odd jobs of revetment) are virtually out of the count for the future. Experiments with new revetment materials as sheet asphalt, special cement concretes and special reinforcing metals are also left for future consideration.

Revetment Construction

What are the contractor's chances in revetment construction? Methods of revetment on the Mississippi are virtually standardized not only in the construction of the older types as willow brush mats but also in the fabrication and the placing of flexible mats of precast concrete slabs and blocks and their upper-bank extension of concrete paving. These are large and costly plant operations.

The government has the only plants for producing concrete mat revetment. It has enough plants in operation and under construction to build all the revetment provided for in the estimated allotment of about $6,000,000 a year. It has built all the concrete revetment that has been built. In brief, it has a running start in a competition where the contractor must start from scratch. Altogether the contractor has a more difficult task to break into revetment construction than into almost any other parts of the flood-control work. Contract construction, however, is not devoid of possibilities.

Concrete Revetment Structure—A concrete bank-revetment consists of an under-water flexible mat of articulated, precast concrete blocks or slabs, an upper-bank slab pavement with an inverted curb at the top, and a connecting belt of concrete laid in place and welding together the upper edge of the under-water mat and the lower edge of the upper-bank paving. The construction operations are: (1) Precasting the slabs or block mats, (2) laying the under-water mat, (3) grading the upper bank, (4) concreting the connecting belt and (5) paving the upper bank. The initial block casting and the laying of the under-water mat come first, the mat being held to the shore by cables to inshore deadmen. The bank grading, concreting the connection and paving the upper bank may follow the mat laying immediately or may be done later as a separate operation. This is concrete revetment construction in the barest outline. The process is one of many details.

Revetment Plant—The plant required for block-mat revetment as the government is now doing it may be summarized as follows: One bank grader, $50,000; one mat-laying boat, $140,000; two mooring barges, $50,000; two upper barges, $20,000; one quarter boat, $20,000; 50 barges for materials and precast units at $8,500 each or $425,000; one mixing plant on barge, $100,000; one gravel dredge, $50,000; one bank-paving outfit, $50,000, and two towboats, $200,000. The grand total plant investment is in round numbers $1,000,000. The whole is floating plant. This is the plant the contractor must provide for revetment work by present methods. About $350,000 worth is special equipment—the hydraulic bank grader, the bank paver, the mat boat and the mixing plant. The remainder is general-purpose equipment suitable for any kind of river construction work. The four special-purpose units also have a certain dismantled value in machinery as mat-boat cranes, mixers, bins, towers, batchers, pumps, etc. While, then, the investment in a concrete revetting plant is large, only one-quarter to one-third of it is strictly special-plant investment.

Improvements in Structure

So much for plant and structure and construction methods as of present practice. There is no thought by the government engineers that they have attained final results in either. The indications are that the structure type is a good one. Recent under-water surveys by divers show the mat blocks solidly in place and cemented firmly by river deposits but with the wire ties more or less gone, depending upon age and section of metal. Two conclusions may follow: The section of the present galvanized ties can be increased or a copper-clad wire substituted, or the ties and reinforcement can be cut down virtually to the point where they barely hold the blocks together during sinking and until they have cemented themselves in place with mud. The larger or better metal ties add to the cost and the other resort reduces the cost. Cost reduction is greatly to be desired. There is opportunity for study and invention in improving revetment mat structure.

It is the same with the upper-bank paving. This is now a 4-in. slab with a reinforcement of rather large-section, wide-mesh wire fabric. It is open to question whether a light-wire close-mesh fabric, virtually chicken wire, might not do as well or better in holding the slab together, which is about all that the present reinforcement can be counted upon to do. In brief, the end of improvement is not yet reached in any part of the concrete revetment structure.

Improvement in Construction

Also, finality has not been attained in construction methods and plant. The present casting plants are floating plants. Essentially they consist of a string of barges

moored along shore, a mixing-plant barge which moves up and down the string filling the block-mat molds, and various service boats and barges. A description of a casting plant was published in *Engineering News-Record*, March 15, 1928, p. 434, which can be referred to for details. Locations are selected (1) within economical towing distance from gravel dredge to plant and from plant to revetting operation and preferably where the loaded barge haul from both dredge and plant will be downstream, (2) where foreshore and navigation conditions are favorable, and (3) where land access by railway and road is convenient.

Casting plant improvements have been improvements in detail. For example, the mixing plants now being built are much improved outfits, with electric power, with

MAT BOAT LAYING CONCRETE BLOCK REVETMENT
This is one of the unique pieces of equipment developed on the Mississippi River. Its operation was described and illustrated in *Engineering News-Record*, March 15, 1928.

steel bins, batchers, inundators and all the paraphernalia for producing a designed mix and accurate concrete control. New barges and servicing plant generally are better than were those first used. Fundamentally, the plant remains unchanged.

So far the original convictions have not altered that a floating plant gives a desired mobility, easy adjustability to fluctuating river levels, cheap delivery of materials and shipment of product, and a minimum of rehandling compared with any shore plant plan that has been offered for consideration. There is a possible field of study by manufacturers and contractors (1) into the possibilities of shore casting and barge delivery and (2) into improvement of floating plant layout and mechanization. It seems an unwieldy procedure, for example, to shuttle a mixer boat and attendant barges up and down a line of mat barges casting successive layers of block-mats aggregating 15 to 18 cu.yd. per layer per barge, but so far there has appeared no substitute arrangement which compares favorably in plant investment and production cost.

The plant for laying under-water mats of the types now being put down has been highly developed. The mat-boat is a wholly extraordinary mechanism for handling large weights and masses, and the attendant outfit for mooring and shifting the mat boat and getting the mat barges to and away from it are remarkably well devised. There are improvements in detail which experience has shown to be desirable, but the mechanization as a whole is serving its purpose excellently.

If mat-laying plant is to be improved greatly it would seem that it must be in the way of radical change in mechanical processes. Working procedure with the present plant offers simpler possibilities. An instance is the alternate mat-weaving and mat-sinking operations with an idle period intervening for one crew while the other crew performs its task. A continuous moving and sinking process would increase output and could be arranged with no great difficulty. Two factors of its success have, however, to be considered. Extra perfect co-ordination in delivering and spotting mat barges would be needful. Also the reaction of labor would have to be appraised. Broadly speaking, periods of intensive activity alternated with periods of rest are more favorably received by labor than is a continuous grind, and at least some experience in construction management shows them to be more productive.

Processes of grading and paving the upper bank offer more apparent possibilities of improvement. Hydraulic grading is now very largely employed and it has the advantages that the barge-mounted outfit can get access to almost any bank, can change position easily and cheaply, and is simple in operation and not unduly expensive. The Mississippi banks where revetting is called for are not generally easily accessible to land excavators nor do they provide easy ways for the travel along bank of such machines. Commonly the hydraulic graders operate two giants breaking down the bank and sluicing the material to a 1 on 4 slope. The sluicing leaves the bank rough, so that it has to be shovel-dressed before the 4-in. reinforced paving is laid. There is room in bank grading for greater evenness and uniformity of the rough grading and a reduction of hand dressing, and contractors and manufacturers have an opportunity to develop improved methods and plant. The government engineers are already studying the problem.

The present standard bank-paving outfit is a barge-mounted mixing plant with hoist tower and chutes and attendant material barges. This plant is not giving the best quality of concrete to be desired for bank paving and the plant itself as now built lacks flexibility. Designed to chute onto high banks at low-water stages, the towers are high and the chute runs are long. At high water and in paving the lower bank the hoist and the chute travel are inordinately great. A quickly adjustable tower hopper and chute connection and provision for quickly reducing the chute length would increase speed and output. There is an opportunity for invention in improving bank paving plant and methods.

Contracting Problems—Assuming a continuation of the present set-up for revetment construction the controlling problem—whatever plant improvements are possible or are made—is co-ordination (1) of production and delivery between plant and (2) of constituent operations of each plant unit. Each plant unit is expensive in first cost and is expensive to operate, and to insure the greatest economy it must operate to capacity and continuously. No plant unit is independent; it is a part of one complete plant and performs only one part of a construction process. There is no gain but only a sure loss in having a dredge which will produce more sand and gravel than the casting plant can work up in precast block mats or a casting plant which can produce more mats than the mat-boat outfit can weave and sink. Nor can the towing plant have a capacity greater than is necessary to move gravel barges and mat barges just as fast as the other units need barge service. These are elementary truths, but they are emphasized to drive home the fact that there are three producing plants and a transportation system, between which precise co-ordination must exist if revetment construction is to cost the least.

The contractor has then in concrete revetment con-

struction a problem of major size in plant planning and co-ordination. He cannot safely contemplate undertaking revetment construction without a careful appraisal of this problem. The government engineers now doing revetment work have appraised it. They have, confessedly, by no means got plant and methods to the degree of perfection where they are satisfied, but they have reached an understanding of the problem and a perfection of accomplishment which makes them dangerous competitors to bid against. Yet competition has an inducement for the contractor. Revetment work is high unit-value work—$250,000 a mile or upward of $40 a linear foot of bank revetted. There are opportunities for making money in such work which are not offered by work of low unit cost. It demands money and a high-grade construction organization and assurance of continuing work, but the hazard is not exceptional. There is no difficulty in specifying revetment construction so as to guard all interests.

Why, it may be said, discuss revetment work for contractors if the government has plant to do all the work planned for some years? The answer is because there is yet opportunity for development in the improvement of revetment structure and revetment construction plant and methods. Because also while it will be subordinated to levee construction in the present program, it is in the mind of every river engineer the ultimate task in control which must be carried out through the years when levees have been completed to the maximum of the present plan or of any plan justified by engineering economics.

Discussion so far has related to block-mat revetment. It was first developed, has been used most and is now the standard in two districts. In the Memphis district in 1927 and 1928 there has been developed a heavier type revetment of precast slabs laid to overlap like shingles on a roof but lapping in reverse order. This is a heavier revetment and costs about 20 per cent more than the block-mat construction. It requires a different kind of mat-laying boat, but in general the outfit is about the same, costing about the same, having about the same proportion of special and general equipment, and requiring the same careful co-ordination of operations. In general all that has been said of the older operation relative to the contracting prospects and problems applies to the newer operation.

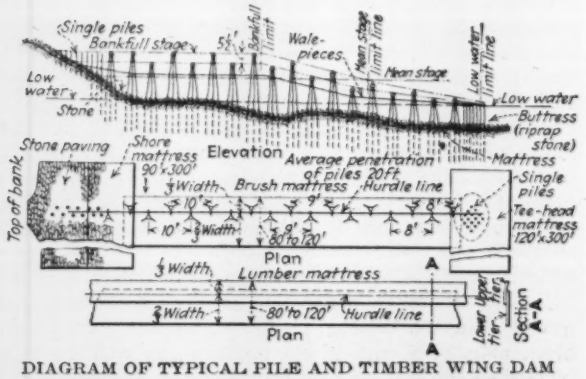


DIAGRAM OF TYPICAL PILE AND TIMBER WING DAM

Permeable dikes (hurdles) of piling driven through foundation mattress are used (*a*) as dams to close chutes or sloughs, and (*b*) as spurs or wing dams to contract the main river to project widths. As closing dams the hurdles conform in height to standard cross-section and are built of four or more rows of clumps of piles and one to three tiers of mattress. As wing dams in contraction works hurdles are built with crests about at bankfull stage between high banks and project limits for bankfull stages, thence sloping to mean stage and to low water at the respective project limit lines for the latter stages. In a series wing dams are spaced 500 ft. to 5,000 ft. apart depending on the secretions expected from them, and their direction is normal to the current or on the shortest line from projected outer end of dike to river bank.

Barring channel contraction works, no type of river construction is so much affected by river levels as is revetment. Over-bank high water will in greater or less number put levee-building plants out of commission, but revetment construction is hampered by any level above low-water stage. At bankfull stages it is stopped. The revetment builder has here a hazard which he must always appraise in figuring costs. Estimates are usually made on the basis of average water stages. Reasonably safe contracting will require some provision in the contract for adjustment of prices when for a season, or a large part of it, water stages are well above the average.

Contraction Works

In the ten-year program, contraction works will call for an expenditure of roughly $2,000,000 a year. From the contractor's viewpoint contraction work is hurdle construction, either as dams for chutes or sloughs or as wing dams. A diagram herewith indicates the construction. It is comparatively simple construction, calling for a moderate floating equipment of piledriver, mattress barge, materials barges, towboat, quarter boat, etc. The government engineers have done a considerable part of past hurdle work; the remainder has been contracted and with larger expenditures contractors will have greater opportunity.

Bonnet Carré Spillway

The general plan of improvement calls for only one major special structure—the Bonnet Carré spillway on the east side of the river just above New Orleans. The structures comprise (1) a concrete weir of ogee section carrying piers with gates between and having a concrete downstream apron; steel sheeting will form a cut-off wall at toe and heel of the weir, and the foundation will be piles; (2) guide levees from each end of the weir to Lake Pontchartrain. The levee work will be a regulation operation. There will be some 110,000 cu.yd. of concrete of simple form in weir and gate piers. Details of the spillway design and structure will be published in a future issue.

Government Repair Plants

In appraising the government engineers as potential competitors in Mississippi flood-control work, a large factor is their remarkable equipment for repairing and rebuilding all manner of construction plant. With their district repair shops and the Vicksburg district engineer shops, the government engineers have means for major repair operations out of reach of the ordinary contractor's field shops. The engineer shops at Vicksburg are veritable shipbuilding plants and have machine shop equipment for very large planer, lathe and shaper work, for electric and oxyacetylene welding, and for sheet metal and light structural steel work. A dragline, towboat, gravel dredge, for example, barring major parts and power units, can be completely rebuilt. With a large stock of spare parts and supplies, these plants are capable of extraordinarily quick handling of repairs and replacements which normally on construction operations have to wait on the manufacturer or large city machine shops.

Summary

In closing this review of contracting problems and prospects in Mississippi flood-control work the facts to

be remembered are: the volume increase of work requires the introduction of new and large construction organizations; these organizations approach a special and unfamiliar task; on the engineers of the work, therefore, there devolves a positive duty to provide information to the bidder which will guarantee to the greatest possible degree his thorough acquaintanceship with the task to be undertaken. On the contractor's part there must be clear comprehension that he has special problems—some of them unprecedented in past river work—in the new construction and that consequently he has a survey and fact-finding obligation to perform first to protect his own business and again to guarantee good construction service to the public. The lesson of these articles to contractor and manufacturer is: "Learn the task by first-hand study in the field and live on the work to watch the details." This is the statement of an engineer whose work on the river has been continuous for 40 years.

Launch Second Diesel-Electric Dipper Dredge

Dredging Contractor Augments Equipment for Chicago River Straightening Job With Novel Power Unit

A DIPPER dredge operated by a 1,100-hp. diesel-electric power unit was launched Dec. 18, 1928, at the shipyards of the Manitowoc Shipbuilding Corporation, Manitowoc, Wis., for the Great Lakes Dredge & Dock Company. It is the second of this type built, the first being the "Crest," launched in Camden, N. J., in 1926 for the same contractor.

The "Mogul," which will supplement equipment and expedite the work of straightening the Chicago River, operates an 8-yd. dipper when digging in rock and a 10- or 12-yd. dipper when digging in soft material. The maximum digging depth is 42 ft. and the pull on the dipper is transmitted through two 2-in. cables.

Hull and main deck house are built of steel and the quarters, for a crew of 23 men, on the upper deck are built of wood. The molded length of the hull is 156 ft., beam 42½ ft. and depth at the side of the hull 12½ ft. The central open machinery pit is surrounded by bulk-headed watertight compartments from the inside of which are built up the heavy scantlings. Two extremely stiff box girders furnish the foundation for the main power unit, which is a two-cycle diesel engine, direct-connected to four generators mounted on a single shaft, which in turn furnish current for the main motors through Ward-Leonard control. Auxiliary power is furnished by a 120-hp. two-cycle diesel engine direct-connected to a 75-kw. generator. The two engines furnish current to the 28 motors driving the various units throughout the dredge.

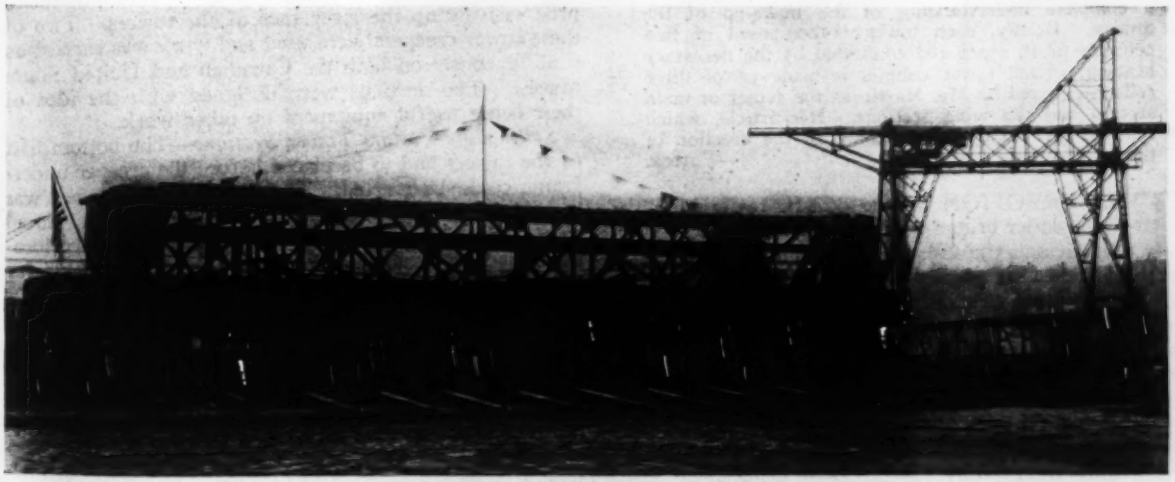
Extreme care is taken with the engine setting to see that absolute bearing is obtained at every point. In addition to careful planing of the top plates of the box girders, methods akin to "make ready" in a print shop are used in the last refinements. The reason for this extreme care is to eliminate any possibility for any initial point of vibration. Even the cross-diaphrams in the box girder are accurately planed to an exact fit.

Four spuds 48 in. square and 80 ft. long are manipulated by double cable lines running in a diagonal direction from the spud to the driving drums, with change of direction only at the spud. As on the boom, two small cables rather than a single large one are used to avoid accident, since one of the two will give warning of failure in plenty of time to permit replacement. Double lines on the boom eliminate the necessity of a split boom. Heavy springs are provided at the base of the boom to provide for side play in the latter, doing away with the usual method of leaving considerable play in the base bearing.

The general contractor in the construction of the dredge was the Bucyrus-Erie Company, South Milwaukee, Wis.

Bureau of Standards to Study Basic Chemistry of Portland Cement

An experimental cement kiln with a capacity of 10 lb. per hour is being built at the Bureau of Standards in Washington. The purpose is to go beyond laboratory work with small quantities of pure materials and to work with commercial raw materials in a manner more representative of mill practice. This is expected to have a direct bearing on cement manufacture following the discoveries already made at the bureau as to the basic chemistry of portland cement.



HULL OF "MOGUL" ON WAYS READY FOR LAUNCHING

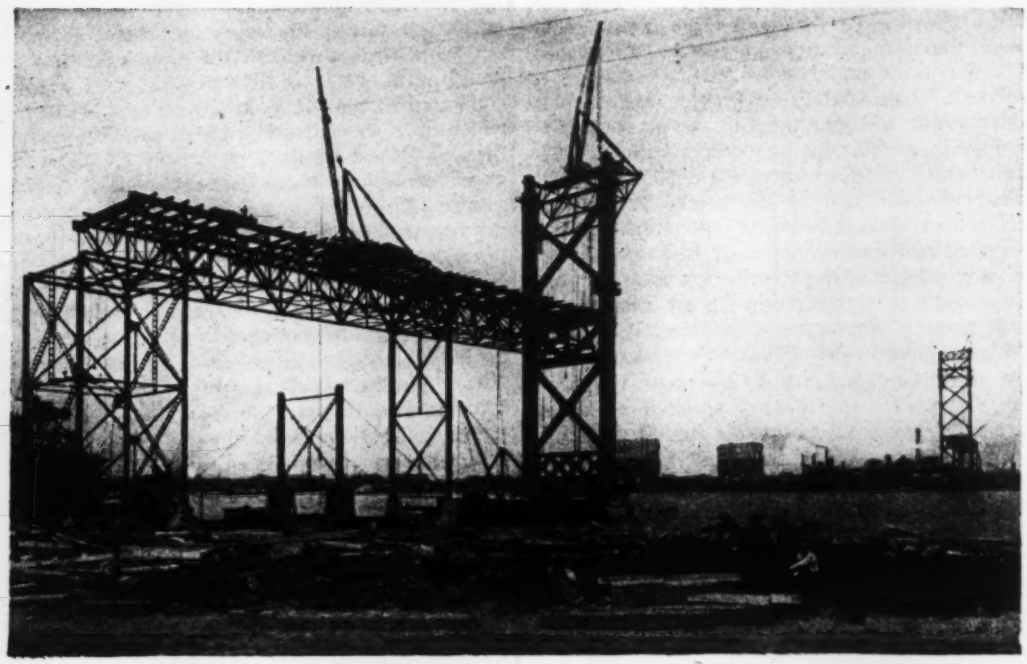


Fig. 1—Detroit River Bridge Towers Under Erection. View From Canadian Side.

Suspension Bridge Tower Erection at Detroit by Creeper Traveler

Sections up to 60 Tons in Weight Handled— Erection Procedure—Adjacent Approach Trusses Also Placed by Creeper Derrick to Give the Tower Erection Stability

By Lloyd L. Martin
Erection Engineer, McClintic-Marshall Company

The Detroit River suspension bridge, with a span of 1,850 ft. is second in length only to the Hudson River bridge, under construction in New York City. A design article on the Detroit River bridge was published in *Engineering News-Record*, Sept. 27, 1928, p. 461, and that article should be referred to for a complete understanding of the make-up of the towers. Briefly, each tower is composed of two columns 67 ft. apart and connected by the necessary bracing. Each tower column is made up of three cells designated by Mr. Martin as the center or main section and the wing sections. His article, which follows, gives a detailed account of the erection of these interesting structures. —Editor.

THE ERECTION of the 363-ft. towers for the Ambassador bridge over the Detroit River between Detroit and the Canadian border cities in Ontario involved somewhat greater problems than other suspension bridge towers recently erected because the average weights of the column sections handled were greater and because the tower was comparatively slender and lacked stability for its full height against wind and erection forces. The heaviest piece handled, the top center section, weighed 60 tons, and there were several other sections weighing between 55 and 60 tons. As these heavy pieces were successfully handled, it is believed an economy resulted from this erection arrangement which decreased the number of field splices and rivets and the number of units to be erected. There were only 23 field rivets per ton of steel.

The erection equipment consisted of a steel stiff-leg derrick carried on a special underframe which was raised progressively up the river face of the towers. Two of these tower creepers were used and work was carried on simultaneously on both the Canadian and United States towers. The derricks were designed with the idea of their being useful equipment on other work.

Setting the Bottom Tower Sections—The bottom lifts of the towers had to be placed before the creeper underframe could be erected. The United States tower was located on land, while the Canadian tower was placed some little distance from shore. These respective locations made necessary different erection arrangements for these bottom tower sections.

The United States tower was located in the Pere Marquette railroad yards and was therefore accessible with locomotive trains. The bases, first lift of columns, bracing and creeper were erected with two 40-ton cranes working from a track located close to the pier. The center bottom section, 47 ft. long and weighing 54 tons, was set up on the base with the two cranes, using 55-ft. booms. This operation involved turning the piece on end from the cars and passing it between the cranes to

erect it on the base. The cranes during this operation were working to their maximum capacity and drift. On account of the length of the section, brackets were attached just above the center of gravity for attaching the crane hooks. These provided the needed drift and acted somewhat as a balance beam. The erection of the creeper itself presented no special difficulty. A crane with a 120-ft. boom was used to erect the derrick members on top of the underframe in its first position. The remainder of the tower steel was erected by the creeper picking the sections direct from cars on the track in front of the pier.

The Canadian tower was located about 225 ft. out from the bank of the river. There was no derrick boat available in Detroit with sufficient capacity and length of boom to erect the first lift of the tower and the creeper. Therefore one of the available derrick boats was used to erect the derrick temporarily on pile clusters on the shore side of the pier in the same relative location to the tower as it would be when on the river side and a part of the creeper. The derrick was counterweighted with beams from the approach span (Fig. 3) and in this position erected the first lift of the tower and the creeper underframe. All steel was delivered by barge from a storage yard on the United States side of the river.

Following the erection of the bottom sections of the tower, the derrick was erected on top of the creeper underframe. The boom was jumped to the bottom strut of the tower and set in a steel foot block. Using one leg of the tower as a mast, it then transferred the derrick mast, sills and stiff-legs to the creeper, after which the

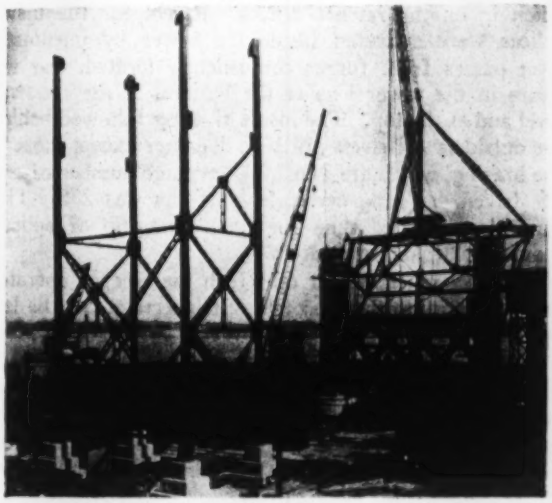


FIG. 2—CREEPER TRAVELER IN FIRST POSITION ON U. S. TOWER
Approach tower bent being erected in foreground.

boom was jumped from the tower strut to its position on the creeper. When the tower was erected and the creeper lowered, it was dismantled by again transferring the boom to the foot block on the bottom strut and reeving up with the roadway strut for the boom falls connection.

The Creeper Traveler—The derrick of the creeper traveler had a sill spread of 67 ft., equal to the distance between the tower legs, and carried a 90-ft. boom having a live-load capacity of 65 tons at a 42-ft. radius. In addition there was a 10-ft. jib on the boom with a 15-ton capacity. The mast of the derrick was set on the center line of the bridge and 15 ft. from the transverse center of the tower legs to allow the tower bracing to be erected with a steep boom, the minimum radius being 13 ft. The details of the creeper traveler are shown in Fig. 4.

The underframe was designed to carry all derrick reaction with the boom in any position ahead of the transverse center line of the tower legs—that is, in an arc of nearly 180 deg. in front of the mast. Only loads were picked behind this line which would give equivalent reactions. The total weight of the underframe was 48 tons and the weight of the derrick 42 tons, so that the weight of the creeper to be raised, including rigging, was about 100 tons.

The creeper was raised to its successive positions by two sets of twelve-part ⅞-in. wire line tackles, the lower

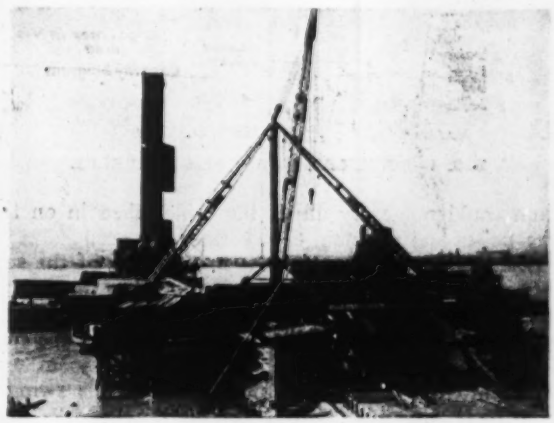


FIG. 3—ERECTING FIRST LIFT OF CANADIAN TOWER
Derrick from creeper set up on piling for this purpose and later transferred to underframe on tower.

blocks being built into the bottom of the underframe and the upper blocks attached to a temporary bracket on the top of last column erected.

When jumping the traveler, the top blocks and brackets had only to be raised with the creeper boom from the deck of the creeper to the top of the next tower section. When the creeper was being jumped, the overturning forces were resisted by rollers at the bottom against the river side of the columns, and by rollers at the underframe deck engaging the outstanding angle legs and cover plates of the wing column section. Sliding side guides were also provided both at the deck and at the bottom rollers. The jumping operation from the time the erection of one lift of tower was completed until the creeper was ready to continue erection was about eight hours.

Two three-drum 135-hp. electric hoists were used to operate the creeper, both of these being placed at the bottom of the tower on steel platforms attached to the tower bases. A steel sheave stick attached to the bottom strut of the tower between the hoists received all of the derrick lines and diverted them in the proper directions to the six drums. Additional sheaves were placed on each tower leg just above the engine platform for the lifting tackle leads. One hoist operated the boom falls, one end of the main falls and the auxiliary falls. The other hoist operated the becket end of the main falls, the elevator cage for taking workmen up and down and one jumping falls. The other jumping falls was placed on the auxiliary falls drum of the first hoist, so that both hoists were used in the jumping operation. Both hoists also were used to raise the heavy sections, since one

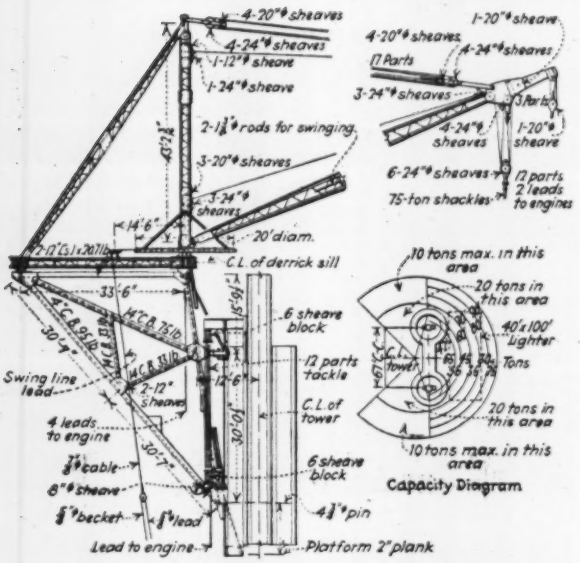


FIG. 4—DETAILS OF CREEPER TRAVELER

drum could not carry all of the cable taken in on the long hoists and maintain the necessary power.

One engine was used for the final setting of the sections after they had been raised, inasmuch as this engine had main, boom and auxiliary falls lines. In addition, the engineer operating this engine also operated the controller of an adjacent swing engine. The boom was swung by four-part tackles running from this swinger to a 20-ft. diameter bull wheel on the derrick. All signals were given by an electric bell system from the deck of the creeper, a separate bell being used for each drum.

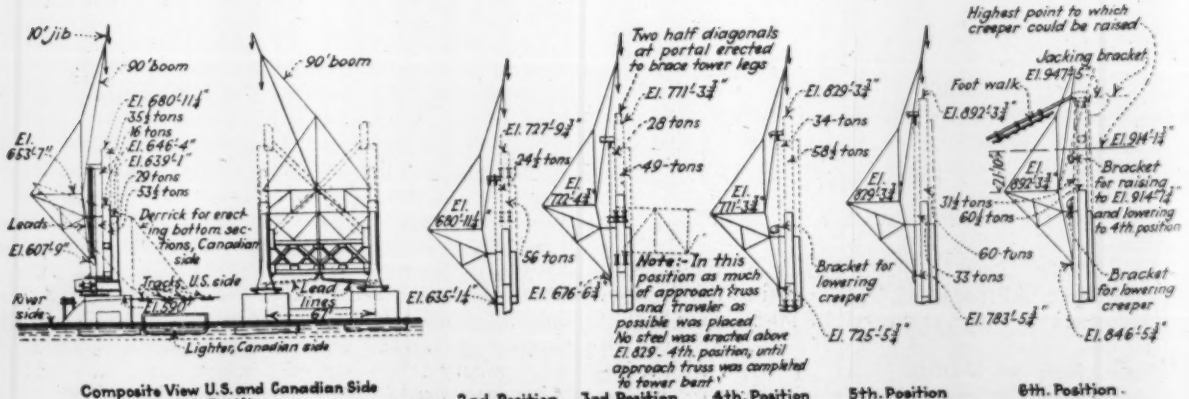
The fastening of the creeper to the tower was accomplished by bolting to the top splice of the column. This connection was made to the bottom half of the splice so that it did not interfere when attaching the next section above. The bottom reaction of the creeper was carried to the tower through a bracket bolted to the rivet face of the tower, and this bracket was pinned to the creeper so that it could be swung away from the tower to clear rivet heads when jumping. No castings were used, the structural details and forgings carrying all of the reaction. The holes for connecting the creeper to the tower were standard for all positions and were carefully located and drilled to templet, when the tower legs were assembled in the shop.

Erection Procedure—The various steps of the erection procedure are shown in Fig. 5. In raising the tower sections, a device was used which bolted to the splice plates and connected to the main fall block swivel with pins and links to permit the up-ending of the sections. The same lifting device was used for the bracing with hitch plates to attach it to the bracing members.

The splice plates were shop riveted to the top ends of the center sections of the towers, but the splice angles were left loose. On the wing sections, however, the splice plates were loosely bolted to allow a horizontal movement of the section being erected so that it would clear the rivet heads on the webs of the center section of th tower which extended above the wing section. The connectors worked from a scaffold built around the tower leg and permanently fastened to the creeper. This platform may be seen in Fig. 2. Generally it was jumped with the creeper, although the portion which fouled the bracing was removed when necessary.

No difficulty was experienced in placing the milled joints in contact. All dirt and excess paint were carefully cleaned from between the splice plates, while in setting a section it was lowered nearly to place and then picked up about 2 in. so that any dirt or paint which had been scraped between the milled joints could be blown out with an air hose. The fitting-up was usually done from the erecting scaffold before the creeper was jumped; riveting followed two splices behind the erection. The riveters worked from steel-frame cages with wooden floors and roofs hung from U-bolts in the splices above by ½-in. wire lines attached to small hand-ratchet drums on the cages. These cages were jumped with the creeper boom when the 150 ft. of ½-in. cable was all taken in on the ratchet drums. Rivets for the inside splices were delivered inside the tower by pneumatic rivet passes from forges conveniently located near the doors in the tower legs at the bottom, at the roadway level and at the top. The inside riveting followed behind the outside. All rivets are 1 in. diameter except those in the bracing, which are ⅞ in. The average number of rivets driven per gang per eight-hour day was 235. This time also included time for final fitting-up of splices, moving scaffolds, forges, etc.

The face of the tower on which the creeper operated was plumb up to the top of the fifth section, but the last two sections tapered in on a bevel of $\frac{9}{32}$:12. This made it necessary to provide a simple and safe means of plumbing the creeper derrick after the fifth position, since the mast leaned about 9 in. in its height. A removable beveled filler was therefore developed and used between the mast base and the creeper frame, while 10-in.



IG. 5—ERECTION PROCEDURE SHOWING VARIOUS POSITIONS OF CREEPER TRAVELER ON THE TOWER

I-beam stools were inserted under the rear end of the derrick sills, capable of being removed and replaced with beveled plates to allow the necessary lowering of the sills. The operation was as follows: The boom was landed on top of the fifth column section to relieve the load at the mast base, which was then jacked up and the changes were made in the beveled sills under it. Then by swinging the boom in line with one sill and then the other and manipulating the four 2-in. tie-down bolts at the end of the sills, the stools were removed and the sills lowered onto the beveled plates.

The lifting tackle lines were made long enough to lower the creeper in two jumps, the top blocks of the tackle fastening to special brackets bolted to the face of the tower legs. The boom was removed with the creeper in the highest position and lowered first, since it could not be carried high enough to clear the tower bracing and because to swing to the side toward one stiff-leg would have caused unequal reactions on the roller guides and lifting tackles and a greater overturning reaction than was provided for.

Tower Stability During Erection—The towers when standing alone and erected to their full height were not able safely to resist wind loads and creeper reactions. Therefore at the roadway level it was necessary to stop tower erection and erect the approach spans as far as the first approach tower bents, these to take the wind reaction from the tower through the truss system to the ground. In Fig. 7 the creeper derrick is shown erecting one of the 37-ton trusses on the United States side. Each of these trusses had a span of 121 ft. and was assembled and completely riveted on the ground. The creeper derrick erected these trusses with about a 76-ft. reach. The tower bent was erected with a locomotive crane.

On the Canadian side, it was necessary to erect two

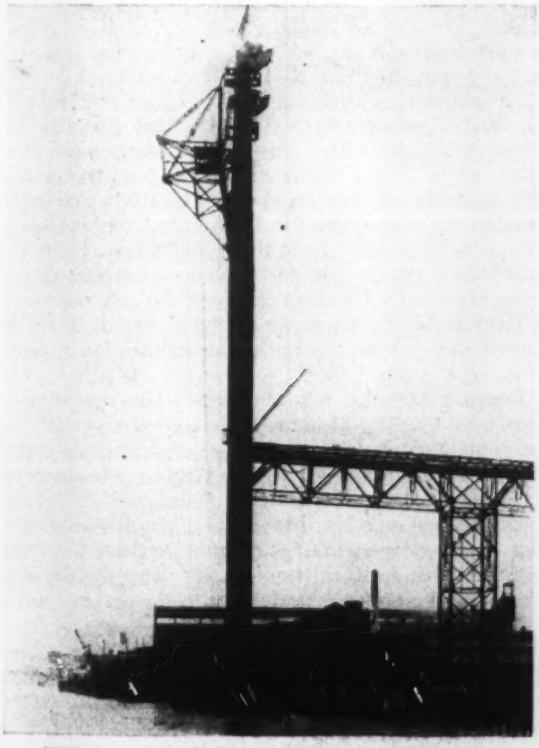


FIG. 6—CREEPER IN HIGHEST POSITION ON COMPLETED TOWER—U. S. SIDE

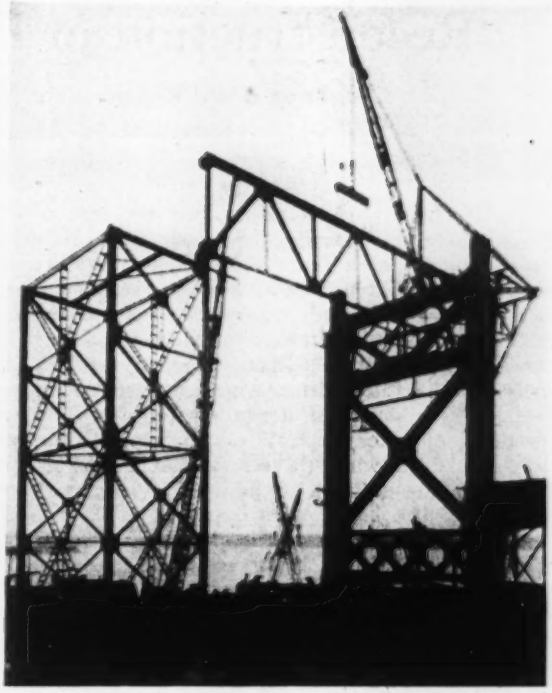


FIG. 7—ERECTING APPROACH TRUSSES TO ASSURE FULL-HEIGHT STABILITY OF TOWER

152-ft. truss spans in order to reach the first tower bent, as shown in Fig. 1. The complete 152-ft. truss exceeded the capacity and reach of the creeper so that temporary steel falsework was erected at the center of the span and the half-trusses erected in units by the creeper. The approach span traveler was then erected on this half-span and proceeded with the truss erection toward the tower bent. The steel used for the temporary falsework was the bent from the span ahead of the one being erected.

Administration—The erection work was carried out by the McClintic-Marshall Company, Pittsburgh, as engineer and contractor for the complete bridge. G. A. Caffall was manager of erection and the writer was erection engineer. A. Toohey was foreman in charge of the Canadian tower and G. A. McClain was foreman in charge of the United States tower. The erection of the United States tower was started March 31, 1928, and was completed, including erection of cable saddles and rollers ready for cable spinning, July 14. The Canadian tower was started April 30 and completed July 27. This time includes the period of approach truss erection when erection of the tower was suspended. There is approximately 2,265 tons of steel in each tower. The record tonnage erected in eight hours was 185, this being four fifth-story sections.

Long Concrete Runway Feature of New Airport

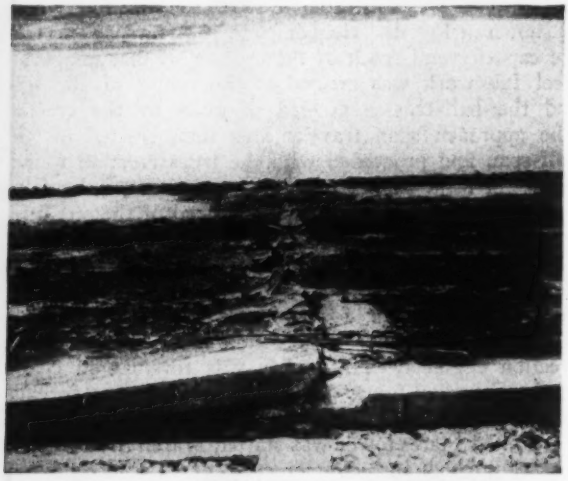
At the Grand Central Air Terminal now nearing completion at Los Angeles, Calif., a concrete takeoff runway 72 ft. wide and 3,000 ft. long has been laid. On either side of the concrete strip is a 10 ft. width of asphalt paving placed as a shoulder, giving the runway a total width of 92 ft. Another important and unusual feature of this new airport is the fact that special emphasis is to be placed on the elimination of dust.

Reconstruction of Lafayette Dam Advised

Consulting Board Reports That Partial Failure of Earthfill Can Be Safely Remedied by Modified Plan, Using Flatter Slopes and Less Height

COMPLETION on a modified program of the Lafayette dam of the East Bay Municipal Utility District in California has been recommended by a consulting board that was retained by the district "to report with recommendations concerning present and future operations" at the dam. This board was appointed after the dam, a rolled earthfill, had partly failed by subsidence when completed to within 20 ft. of the projected height of 140 ft. The first subsidence appeared Sept. 17 and movement continued for eleven days, when the central part of the dam at the crest had sunk 24 ft. Conditions at the dam shortly after subsidence began were described in *Engineering News-Record*, Sept. 27, 1928, p. 483, and the appointment of the consulting board was announced Oct. 25, 1928, p. 634. This board, consisting of Charles D. Marx, Charles H. Paul, F. L. Ransome and A. J. Wiley, convened first on Oct. 29 and after exhaustive studies filed its report under date of Jan. 12. The following has been abstracted from the report:

Geology—The area in which the Lafayette dam is located is underlain entirely by the Orinda formation



LOOKING DOWN UPSTREAM PAVING OF DAM
The amount of uplift in a contraction joint is shown. The upper berm shows white part way down the slope. Spalling and buckling occurred along many of the joints.

(of Pliocene age), which "consists essentially of beds of deeply coherent gravel, sand and clay with all gradations between these materials." The pebbles of the gravel for the most part are less than 2 in. in diameter and of the material forming the typical clayey beds more than 67 per cent passes through a 200-mesh screen. "When in place, undisturbed and fairly dry, the Orinda beds have the rigidity of very soft rock, but when wet they are little more than well-compacted layers of gravel, sand and clay." The beds are closely folded, locally, along lines approximately parallel with the axis of the dam, which "has practical significance in that such structure prohibits general sliding, in a downstream direction, of any considerable mass of rock along any particular bed of clay.

"The structure opposes, also, the escape of water from the reservoir along any particular layer of conglomerate." Despite its weak character, "the Orinda as a whole offers rather high resistance to the passage of water and, owing partly to the inclination of the bed, provides an adequate foundation for the present earth embankment. As far as can be ascertained, the Orinda formation is in no way responsible for the failure."

Streams in the Lafayette region flow not on the Orinda as a bedrock but on an overlying alluvium divisible into two classifications: (1) a surface soil of dark adobe ranging up to 15 ft. thick and (2) a lower

LOOKING WEST ALONG THE DOWNSTREAM TOE OF THE DAM
In left foreground note material thrust out over original ground surface.

and much thicker stratum of alluvium consisting of fine, sandy, plastic clay with occasional gravel. Test borings after the slump show this lower alluvium to contain up to 25 per cent moisture. This homogeneous material lies in more or less horizontal strata and "when subjected to a concentrated load it is possible for the material to flow away from the loaded area and upward toward the surface. The fact that the dam rests directly on the plastic alluvium, which in the deepest part under the dam is 90 ft. or more in thickness, is, from the point of view of the geologist, the critical factor in the failure of the structure."

Materials for the fill, obtained from the side hill slopes near by, "are all more or less clayey in character. The central core section was selected for its watertightness and is about 70 per cent clay. The upstream part contains about 45 per cent of clay and 22 per cent of grit retained on a No. 14 sieve and is practically watertight. The downstream part is of selected material from the Orinda formation, which was of the most granular and porous material available, but it contains an average of about 20 per cent of clay."

In building the dam "the upstream and core sections were spread in 8-in. layers and the downstream part in 12-in. layers with enough water to secure the greatest degree of compactness under heavy rolling. The resulting embankment was extremely compact and very satisfactory for the purpose intended."

Results of Subsidence—The subsidence involved a medial section of the dam about 525 ft. long on the crest which merged into a slumping of the downstream face and pushed up a small ridge parallel to the axis of the dam along the downstream toe, as shown in the accompanying illustration. The subsidence amounted to 24 ft. at the crest and affected an area comprising about eight acres on the top and the downstream slope of the dam. The central portion of this area was moved downstream about 20 ft. by the slump, the entire area coming to rest at a slope of about 3½ to 1.

This movement was accompanied by crescent-shaped cracks concave to the downstream side and approximately tangent to the crest of the dam. "At the surface these cracks are nearly vertical. It is probable, however, that with increase in depth they dip north (downstream) at increasingly flatter angles and that at some undetermined distance above the bottom of the dam deformation by fractures passes imperceptibly into deformation by plastic movement."

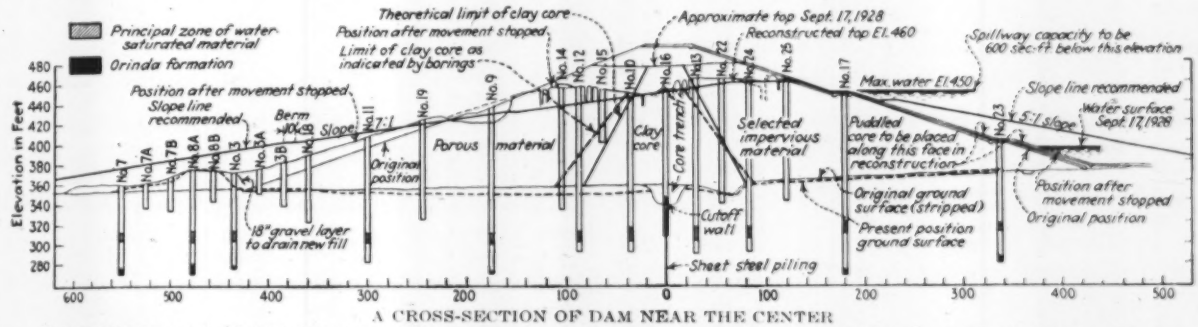
Upstream movement was much less extensive, the maximum horizontal displacement being 5.5 ft. with a maximum subsidence of about 1.5 ft. The concrete paving was somewhat displaced and berms were curved convexly upstream. Five test borings put down along the upstream side after the slump showed well-compacted material with no cracks and it is believed that no ridge was formed at the upstream toe.

Borings show the original ground surface under the dam to have undergone a maximum subsidence of about 9 ft. Comparison of areas representing subsidence with areas representing elevation indicates that only about half as much material has been elevated above the original ground surface as is apparently lacking below that surface. This difference may represent the compression of the alluvium, this thought being borne out by the behavior of water in test holes. The clay core has apparently settled and spread with preponderant movement in a downstream direction; the concrete cutoff wall, however, appears to be in its original position and at its original elevation.

In test borings made before construction no water rose to the surface. In test holes drilled after the slump no free water was encountered until the original ground surface was reached and no considerable quantity was developed above a water-yielding stratum about 50 ft. below the original surface. "When this stratum was reached, water rose in the test holes much above the original ground surface, the maximum height being in test hole 24, where the water rose to 97 ft. above the present depressed ground surface, or 64 ft. above the water in the reservoir. . . ."

"The height to which water rose in each hole is related to the loading imposed at each locality by the dam. Assuming a water level prior to the building of the dam, 20 ft. below the surface, the ratio of the rise in the water surface to the depth of filling in the dam was quite close to a constant with an average of 1.35, except near the two toes. Near the downstream toe the ratio was greatly increased, probably due to the concentration of laterally compressed material as well as to the small amount of superimposed loading at that point. Near the upstream toe the ratio, while higher than the average, is considerably less than at the downstream toe, as would be expected."

Cracks up to 1½ in. wide in the outlet conduits were noted in which the longitudinal reinforcing steel had been ruptured. These cracks were probably caused by the downstream thrust upon the conduit collars at the time of the subsidence.



A CROSS-SECTION OF DAM NEAR THE CENTER

This section is taken at station 11+58. The location of test holes and also the points at which water-saturated material was found and where the Orinda formation was found are shown on the borings. The section recommended by the consulting board has been added to this cross-section.

Causes of Failure—Although the dam contains a larger proportion of clay than is desirable in such an embankment, "the dam would have shown no weakness had it rested upon a firm foundation." Its slopes were conservative, the materials were selected and distributed with unusual care, and the workmanship was excellent. Explanation of its failure lies in the exceptional foundation conditions, notably the uncommon thickness of the clayey alluvium forming the foundation and the general plasticity of this material. Indications strongly suggest the flow or squeezing out of plastic material from under the most heavily loaded region under the core, chiefly toward the region of least pressure at the downstream toe.

"The observed deformation of the dam shows that whatever may have been the initial rigidity of the structure, that rigidity was in part lost when the foundation yielded and a part of the dam near its base moved as plastic material. It appears to be fairly established that the ridge at the downstream toe attained a part of its height before movement began in the body of the dam.

"Although, as has been shown, the compressed alluvium is extremely impervious, it is considered probable that during the early stages of compression some of the water from the deeper alluvium was squeezed upward into the soil under the dam and even into the materials of the dam itself, thus increasing the plasticity of materials that formerly were fairly dry. . . . The immediate cause of the failure was the overloading of the foundation by a combination of height and steepness of slopes."

No plastic layer has been completely squeezed out from under the dam and the alluvium as a foundation material is no more stable than it was originally. The

structure as a whole is in equilibrium because the maximum load has been decreased and redistributed over a larger area. Thus there is index of the relation between slopes and load which cannot be exceeded without danger—in other words, data that may be used, with proper factors of safety, in a design for a dam that will be stable on this foundation.

Conclusions and Recommendations—The modified section recommended for completion of the dam has a height of 100 ft. instead of the originally proposed 140 ft. and the maximum depth of water is correspondingly reduced from 116 to 76 ft. The prescribed slopes are 5 to 1 and 7 to 1 on upstream and downstream faces, respectively. In addition to this extension of both slopes the revised plans call for the removal of all material remaining above the modified section and also of the upthrust ridge at the downstream toe.

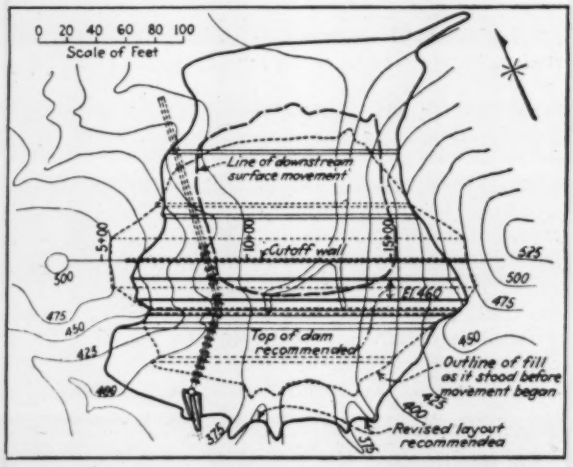
A puddled trench under the new upstream toe will be carried up as a puddled core against the present concrete paving, thus providing a watertight blanket overlain by the new fill. On the finished upstream face no heavy paving will be required because of the flat slope. Oil surfacing, however, is suggested. It is not proposed to excavate any of the disturbed material below the lines of the new section. "Any fissures remaining in the surface of the new section should be filled by hydraulic methods to give a compact and permanent surface."

Because any leakage from the conduits through the dam would enter the overlying embankment, it is recommended that steel lining extending the entire length of the conduits should be put in and calked from the inside. This lining should be independent of the conduit with intervening space for drainage and should have complete exterior protection against corrosion.

The spillway, which had not been constructed when the subsidence occurred, should be so designed that it will have a capacity of 600 sec.-ft. with the reservoir level at the prescribed limiting height. The report concludes:

"1. The partial failure was caused by too great a concentration of load on an unusually thick and plastic deposit of alluvium.

"2. The dam was well designed for ordinary foundation conditions and was well constructed, but the failure disclosed characteristics of the foundation that were not evident from the original borings and could not have been determined from small-scale tests.



PLAN SHOWING LIMIT OF SURFACE MOVEMENT
The outline of the revised layout of the dam is shown as a full, heavy line.

LOOKING EAST ALONG THE CREST OF THE DAM
Camera on edge of undisturbed crest. The downstream slope of the dam is to the left of the picture. Top of sunken portion at left is tilted downward toward upstream side.

"3. Previous failures of earth dams by subsidence have usually been due to movement that originated in the embankment itself. Failure of a dam of this type caused by the plasticity of the underlying foundation has been extremely rare, if, indeed, it has ever occurred. As has been shown, in this instance the characteristics and consequences of this condition of plasticity were determined only by the most painstaking examination after the failure. The consulting board is of the opinion that only in the light of exceptional experience could the mobility of this foundation material have been anticipated.

"4. The Lafayette failure has afforded a full-sized demonstration and points to the particular precautions to be taken when an earth dam is to be founded on a thick alluvial deposit.

"5. Storage in the vicinity of the Lafayette dam is very necessary in the operation of the new aqueduct, but by reason of the recent merging of the old and new systems the amount provided by the original design of the Lafayette dam can be greatly reduced.

"6. To provide for this reduced amount of storage and to avoid the perpetuation of an unsightly blemish upon the landscape, the board recommends the reconstruction of the dam to a height of 40 ft. below that originally planned, with greatly flattened slopes, upon a base twice as long with respect to the height as the original and impounding 3,700 acre-ft. of water as compared with the original capacity of 10,590 acre-ft.

"7. The construction as recommended by the board, and shown in detail in the body of this report, is of extremely massive and conservative design, and will give a safe and dependable structure.

"8. It is roughly estimated that the work of reconstruction will cost about $300,000."

California's Biennial Road Budget $50,000,000

California's biennial state highway construction budget recently prepared for submission to the state legislature by C. H. Purcell, state highway engineer, will exceed $50,000,000. A budgeted program for state highway expenditures, based on local needs and fitted to a conservative estimate of revenues from the gasoline tax and other sources, is a new procedure in California's highway program. Planning over a longer period, it is claimed, permits earlier completion and lower costs.

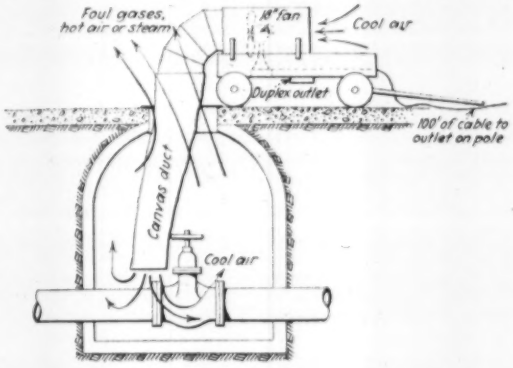
From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Manhole Ventilator

A HANDY device for the ventilation of manholes has been developed by John Gilkeson and L. L. Godfrey, of the steam heat department of the Kansas Power & Light Company, at Topeka, Kan.

Everyone connected with steam heat knows that with no means of ventilation it is a matter of five to ten hours after the manhole cover is removed before it is safe



HOW THE MANHOLE VENTILATOR OPERATES

or even mildly comfortable for an experienced man to enter and work in the manhole. This equipment was developed following a near-fatal case of a workman being overcome after entering the manhole, even though it had been uncovered for more than five hours. With the use of this machine a manhole can be entered in complete safety by inexperienced men in from ten to fifteen minutes after the cover has been removed.

The construction is very simple and inexpensive. An ordinary boy's coaster wagon of all-steel construction was purchased and fitted with an ordinary 18-in. non-oscillating desk fan, a hood, an 18-in. galvanized furnace elbow, a canvas discharge duct 18 in. in diameter by 4 ft. long, and 100 ft. of rubber-covered, double-conductor, 110-volt extension cord. On one side of the wagon a rack was arranged upon which to coil the cable when not in use. A duplex convenience receptacle was also attached to the under side of the wagon to permit the use of a drop light and electric drill or other tools in the manhole.

VENTILATOR FOR MANHOLES SET UP FOR USE

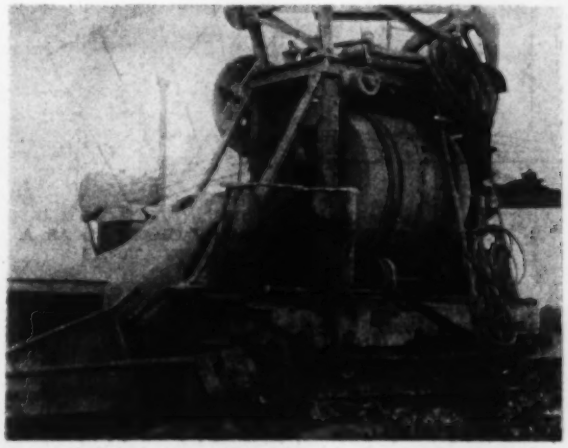
It was then necessary to install within 100 ft. of each manhole a weatherproof convenience receptacle for attaching the cable. These receptacles were placed about 20 ft. above the ground on the company's electric distribution system poles.

The accompanying illustration shows the equipment set up for use, and the drawing indicates more clearly the manner in which it operates.

Automatic Measuring and Charging Tank for Calcium Chloride

By Harry D. Wells
Resident Engineer, State Highway Department, Concord, N. H.

THE acompanying illustration shows a device for automatically charging a measured amount of calcium chloride solution into the drum of a concrete mixer. It consists of two supply tanks made of two oil drums,



CALCIUM CHLORIDE CHARGING DEVICE FOR PAVING MIXER

and a measuring and charging tank holding the amount of solution necessary for one batch of concrete.

The supply tanks are attached to the frame of the mixer and are fitted with pipes and valves so that the solution can be drawn from one as it is being mixed in the other. The outlet of these tanks is connected to the measuring and charging tank by a flexible hose. The measuring and charging tank is attached to the material-charging skip at a point such that it shall be below the level of the outlet of the supply tanks when the skip is lowered and well above the mouth of the skip when the skip is raised. The outlet pipe from this tank is fastened to the side of the skip and directed into the drum of the mixer.

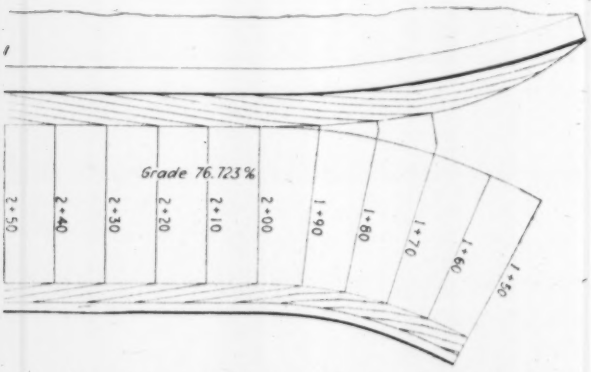
When the skip is lowered the solution flows by gravity

into the measuring tank until it is filled. As the skip is raised the supply is automatically shut off and the solution flows by gravity into the drum of the mixer.

Laying Out a Curved Spillway for Concreting

By Daniel McFarland
Storrie, Calif.

On the Exchequer dam there were two side channel spillways, both designed to take advantage of the topography of the rock and consequently having fairly sharp curves, a steep grade which varied up to a maximum of 77 per cent and walls having a batter of ¼ : 1 and ½ : 1. The excavation was carried on from center line points and lines normal to the center line, but it was impossible to lay out the concrete work in the same way, since the concrete was to be poured in horizontal layers and the center line points would be buried before the tops of the walls opposite them were poured. Also it would be impossible to work from the finished surface of the floor of the spillway channel after it was poured, so it was finally decided to set points at the intersection of the floor and the walls of the spillway channel and to run in points that would represent a contour



CONTOURS ON SIDES OF SPILLWAY CHANNEL AS A CONTROL FOR CONCRETING OPERATIONS

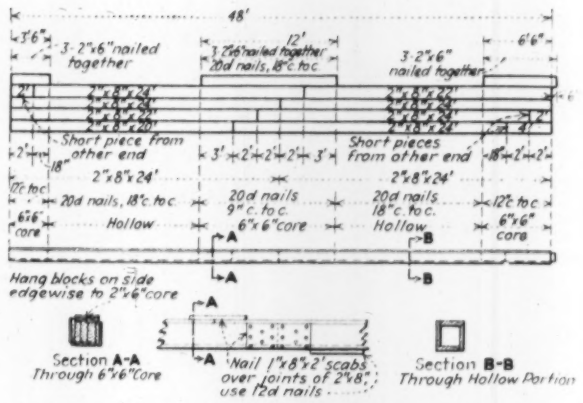
line on the walls of the channel, as shown in the accompanying illustration.

A table was computed and checked showing the deflection angle and chord lengths to use for each transit point. This involved only two transit set-ups per lift and the running in of two curves. Even if the center line point could have been used it would have involved six to eight set-ups, field computations and difficult chaining.

Building a Safe Gin Pole

From the combined experience of its erection foremen and finally as a result of a series of comparative tests, the Chicago Bridge & Iron Works has adopted a standard gin pole for use in erecting elevated tanks. In this type of work the heaviest pieces handled are tower-post sections made up of 10- or 12-in. channels with lacing and cover plates weighing from 1,500 to 3,500 lb. The standard gin poles therefore would be suitable for any other work where the loads did not exceed 3,500 lb. and where the length of pole was under 50 ft.

The following information and the illustration were given by C. W. Hines in the company's publication, *The Water Tower*. Mr. Hines states the advantages of the



ARRANGEMENT OF LUMBER IN 48-FT BUILT-UP GIN POLE

built-up wooden gin pole as follows: (1) It is the strongest pole for amount of material used; (2) it is comparatively light and easy to handle; (3) hidden defects in the lumber are not as important as when solid timbers are used; (4) all of the lumber in the pole can be recovered and being of 2-in. plank is of wide general use.

The accompanying illustration shows the make-up of a 48-ft. gin pole suitable for a safe load of 3,000 lb. boomed 20 ft.

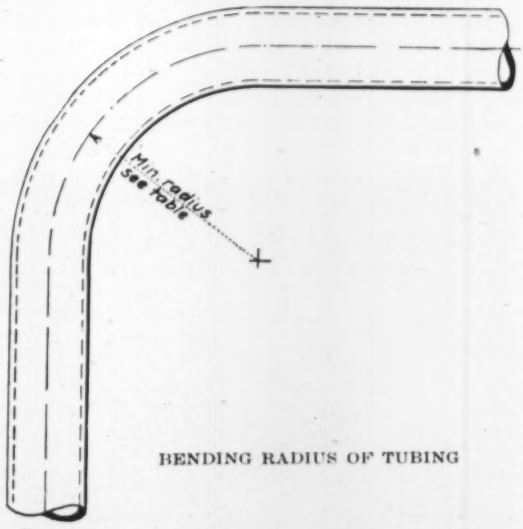
Bending Tubing

By Morton Schwam
Philadelphia, Pa.

Bending tubing for structural members should be held to the radii given in the table below, as developed from actual experience.

Material	Min. Rad. = O. D. × Factor Below	Material	Min. Rad. = O. D. × Factor Below
Aluminum	3	Lead	3
Duralumin (heat treat before bending)	6	Steel	5
Copper	3	Brass (unannealed)	6

If a smaller radius is attempted, the tubing will have



BENDING RADIUS OF TUBING

a tendency to split. Where practicable a larger radius than that specified is desirable.

Aluminum, duralumin, copper, lead and steel tubing should be filled with sand for bending. Brass tubing should be filled with rosin.

Letters to the Editor

Maintenance of Berms

Sir—Your Jan. 3 issue is of great interest, for you have brought out a lot of new thoughts on roads. I thoroughly agree with your demand for berms to hold the fellow who gets off the road where the road metal is narrow. But on the other hand my thoughts recur to troubles we encounter along our main highways.

We build a concrete road 18 to 20 ft. wide, and slovenly drivers keep the berms cut up. Trucks and buses make little effort to keep on the hard surface at all times. We have a new concrete highway, built a couple of years ago, on which it seems impossible to maintain berms. We built them of slag and "red dog," and trucks cut into them until the water gets underneath the road metal. I cannot believe that it is necessary for trucks to cut up the road as many times as they do. Where the paved surface is less than 18 ft. wide I have no fault to find with drivers who go off the road metal, but it does make me peevish to see our new roads being damaged by ruts full of water. P. J. FREEMAN,

Pittsburgh, Pa. Jan. 7, 1929. Chief Engineer of Tests, Allegheny County.

Observations on Contracts for Public Work

Sir—Your editorial comment in the issue of *Engineering-News-Record* of Oct. 25 on the trial of two engineers in New York City for malpractice was timely. Engineers occupying positions of trust are required to be particularly scrupulous in all their dealings with clients and, as representatives of those clients, with contractors. This strict adherence to ethical conduct is all the more important in those cases where engineers are employed by public bodies. Contracts should be carefully drawn and fairly awarded, and the work should be supervised in a thorough manner.

The writer was for five years secretary of the North Carolina Board of Registration for Engineers and Land Surveyors, and for one year was chairman of the board. He has served as chairman of the professional practice committee of the North Carolina Society of Engineers. In these capacities he has had many cases of unethical practice brought to his attention and has learned of public criticism of engineers engaged in municipal work. While this experience has been limited to one state, it is possible that the same criticisms are prevalent in other states. Not only do individual engineers suffer from these criticisms but the public estimation of the entire profession is lowered.

In municipal work, the four things responsible for a large amount of public criticism are as follows: (1) Asking for alternative bids; (2) awarding a construction contract on unbalanced bids; (3) advising continuing contracts; (4) specifying a particular material or construction method, rather than giving specifications for such materials or methods. These faults, if they be considered as such, are not so much faults *per se*, but, present in municipal contracts, they make it possible for both public officials and engineers to follow the "path of least resistance."

Alternative Bids—In many advertisements for bids on public work, alternative bids are asked. Where the engineer and public officials thoroughly understand the merits of each item—principal or alternative—on which bids are asked and will award the contract on a price basis, all of which is understood by the contractors before the bids are received, there can be no possible objections to such use of alternative bids. But this method can be carried to an absurd length. For example, in asking for bids on city paving, there will often be included every conceivable type of paving, even though the engineer and city officials know that the paving will be limited to only a few standard types. It is true that certain items, covering types of pavements, are selected for a comparison of bids, but often these items are not selected and known to the contractors until after the bids are received, and before actual construction is undertaken the types of pavements may be changed by the municipality. All of which afford many loopholes for favoring one contractor above others and results in public criticism. It is certainly right to presume that the municipal engineer and public officials know as much about pavements before bids are received as afterward, and there is no reason why types cannot be selected when the work is planned and before bids are asked. The evils resulting from the indiscriminate use of alternative bids have been illustrated by reference to paving; the same evils might result from their use in any kind of public work.

Unbalanced Bids—The evils resulting from unbalanced bids are pointed out in all discussions of engineering contracts. If quantities were correctly estimated by the engineer and a comparison of bids made on a basis of all items included in the contract, there would be few evils from such bids. The evil results (1) when actual quantities differ greatly from estimated quantities; and (2) when changes are made after the award of a contract necessitating the use of a type, method or material on which prices were asked in bids, such prices, however, not being used in a comparison of bids. The first evil is chargeable directly to the engineer, except when estimated quantities are changed through an extension of the work; the second evil may be charged to both engineer and officials. In either case such unbalanced bids, where permitted by the engineer, is another means by which a particular contractor can be favored. Where, as the result of such bids, public work costs more than was anticipated the people will be disposed to criticise both officials and engineer, even though there may have been no favoritism actually shown the contractor.

Continuing Contracts—Most contracts for public work state that the estimated quantities are approximate only and can be added to or decreased. Criticisms are frequently made when such a contract is extended to cover a much greater amount of work than was contemplated when the contract was awarded, especially if general construction prices have dropped in the meantime. For example, one city awarded the contract for $1,000,000 of paving. This contract was extended from time to time, at the same unit prices, until the total amount of paving was $3,000,000, though unit paving prices had dropped during the three years the paving program was being carried through. To extend such contracts is obviously the easiest course for both officials and engineers; but, remembering how vitally the public is interested in the work and how critical it is of such extensions, the engineer should, in most cases, ask for new bids where a material quantity of additional work is to be undertaken.

Materials and Methods—Little comment is needed concerning the evils resulting from specifying a particular kind of material or method instead of giving the specifications for such material or method. In general, engineers are prone to do this only for small items in a contract. But sometimes it is extended to the larger items. The engineer is then besieged by representatives of various companies seeking to have their materials or methods adopted. This puts a burden upon the engineer, and his action is subject to criticism, depending on which material or method he selects. It is granted that it is much easier to specify a particular product, especially for small items, than to cover its design and construction in specifications. But engineers should be extremely careful to avoid specifying particular materials or methods which will lead to public criticism of their acts, whether such criticisms are just or not.

It will be noted that the four things occurring in contracts for public works which result in criticism of engineers are very closely interrelated. With competent and honest officials and engineers such contracts can be used with full protection to the public. But even then the use of such methods may be responsible for criticism, even though no evil result from their use. The uses that can be made of such contracts by incompetent and dishonest public officials and engineers are obvious.

The engineer should be particularly careful, in his handling of public work, so to conduct the work that no criticism can attach to him or to the honorable profession of engineering.

HARRY TUCKER,
Professor of Highway Engineering,
North Carolina State College of Agriculture and Engineering.

Raleigh, N. C.
Nov. 12, 1928.

News of the Week

Canadian Pacific to Build 1,200 Miles of Branch Lines

Expansion involving construction of approximately 1,200 miles of track into virgin country in western Canada at a cost of not less than $50,000,000 is indicated by the application of the Canadian Pacific Railway to Parliament for permission to build new lines. The most important of the proposed branch lines affect the far northern section of Saskatchewan. It is proposed to build a line from Nipawin straight north to Island Falls, across the Churchill River and farther north to Reindeer Lake. It is also likely that the railway will seek rights to branch off at Island Falls and cut through the mineral areas of Flin Flon and Sherritt Gordon and tap the Hudson Bay Railway at a point well toward Churchill. At present the company has a charter to build a line from Nipawin to Prince Albert.

Pipe Line to Supply St. Louis With Louisiana Natural Gas

A 22-in. pipe line 450 miles long will be built this year to supply industries of St. Louis with natural gas from the Monroe and Richland fields of Louisiana. The system will comprise five pumping stations and will have a capacity of 100,000,000 cu.ft. per day. The project will be built by the Mississippi River Fuel Corporation at a cost approximating $30,000,000.

California May Have State Owned Toll Bridges

A plan for state owned and operated highway toll bridges financed with income bonds secured solely by the revenue from tolls is before the California state legislature. Advocated by the state highway commission, the proposal would prohibit all subsequent building of private toll bridges and permit the state to acquire those now in existence. Tolls charged by the state would be just sufficient to extinguish costs as rapidly as practicable, after which the bridges would be free to the public

Private bridges, it is charged, require excessive promoting and financing costs reflected in the tolls and are located at advantageous points capitalizing the public investments in highways without regard for the ultimate state system. The granting of toll bridge franchises based on laws of 1872 and 1883 delegating rights to counties, it is further stated, does not conform to the present idea of a state highway system. This proposed program is a result of a two-year study by the highway commission of private toll bridges authorized by the legislature.

New York Central R.R. Authorized to Lease Its Controlled Lines

But Railroad Must Offer to Purchase Connecting Short Lines Not Controlled by It

LEASE of the Michigan Central Railroad and of the Cleveland, Cincinnati, Chicago & St. Louis Railway by the New York Central Railroad Company was approved by the Interstate Commerce Commission in a decision made public Jan. 26. The New York Central now controls both roads through the ownership of the greater part of the stock of each company and operates them as part of the New York Central system. The leasing is proposed in order to simplify the operation of the two railroads and their subsidiaries as part of the New York Central system.

At the same time that the leasing of the C.C.C. & St. L. was approved, the commission authorized that road to acquire the Cincinnati Northern Railroad and the Evansville, Indianapolis & Terre Haute Railway. The C.C.C. & St. L. now controls the Peoria & Eastern and the Kankakee & Seneca railroads, which will be included in the New York Central system. The New York Central also was authorized to lease the Chicago, Kalamazoo & Saginaw Railway. The unified system will have a total mileage of 11,508.

Short Lines Included

Approval of the lease is conditioned upon the New York Central offering to acquire several short-line railways which now connect with it but are not controlled by it, the New York Central being required to offer "considerations equal to the commercial value of the respective properties as determined by agreement between the parties or by arbitration in the manner prescribed in said leases for valuation of minority shares of stock of the lessors and hereinafter approved by us; and provided further that the right to determine bona fide compliance with the foregoing condition is hereby expressly reserved in us; and, further provided that acceptance of and compliance with the conditions expressed herein and prescribed shall not be interpreted as relieving the New York Central from the further operation of the law respecting consolidations or as excusing that carrier from further responsibility for the representations made on its behalf at an appropriate occasion for considering the inclusion of the so-called short-line railroads, these matters will be approached by the New York Central in the spirit of co-operation looking to their solution with all due regard to the public interest."

The short-line railways which the New York Central is to offer to purchase are the Boyne City, Gaylord & Alpena; Chicago, Attica & Southern; Federal Valley; Fonda, Johnstown & Gloversville; Ulster & Delaware, and the Owasco River Railway.

New York State Road and Bridge Budget Totals $45,560,000

The executive budget submitted Jan. 28 to the New York State Legislature by Governor Roosevelt recommends appropriations of $45,560,000 for highways and bridges, an increase of $1,075,000 over the amount appropriated for such purposes last year.

The following amounts are suggested for highway construction: State aid to towns, $3,105,000, same as last year; state aid to counties, $2,380,400, same as last year; rural post roads, $7,000,000, same as last year; construction of state and county roads, $4,000,000, same as last year; maintenance and repairs of highways, $20,000,000, same as last year; Nassau and Erie county roads, widening of arteries of traffic leading into New York City and Buffalo, $2,000,000, an increase of $350,000 over last year; Jones Beach and Southern Parkway, $4,000,000, an increase of $850,000 over last year.

For bridges the following are suggested: State and county highway bridges, $3,000,000, same as last year; interstate bridges, $75,000, new item this year.

Rapid-Transit Plan for Detroit Submitted to City Council

A plan for a rapid-transit system including one subway and elevated line 13.3 miles long between the east and west limits of the city, a subway running north on Woodward Ave. 1.16 miles from a portal near the Detroit River and a second subway in the downtown section with underground stations and linked to the other subways by underground passenger tunnels has been submitted to the Detroit City Council by the Rapid Transit Commission. The proposition will be voted on at a general election April 1.

The plan involves an expenditure of $51,000,000 for the main subway, $7,500,000 for the Woodward Ave. subway constructed under rapid-transit specifications and $7,100,000 for the short downtown subway in Grand River Ave. for a distance of 0.87 mile, for the operation of street cars. An additional $25,400,000 for equipment for the main subway raises the total estimated cost of the project to $91,000,000.

Rock Island Proposes New Lines

Application has been made to the Interstate Commerce Commission by the Chicago, Rock Island & Gulf Railway for permission to build a new line 97 miles long from Groom to Paducah, Tex. The application further asks the right to acquire by means of joint trackage agreement the Gulf, Texas & Western line from Paducah to Jacksonboro, Tex., a distance of 146.6 miles.

Activated-Sludge Plant Bids Wanted by San Antonio, Tex.

Bids on machinery and other equipment for the sewage-works projected by San Antonio, Tex., will be received on Feb. 11 and for the general construction contract on Feb. 18. Presettled sewage will be treated by the activated-sludge process. The first contract includes a mechanically cleaned bar screen; equipment for two preliminary and four secondary settling basins, for three or four sludge digesters, for sludge filters and a sludge drier; and four motor-driven air compressors. The estimated cost of the sewage-works is $900,000. Hawley & Freese, San Antonio, are consulting engineers for the work. C. H. Chambers is mayor and Fred Fries is city clerk of San Antonio.

Further Federal Reclamation of Arid Lands Opposed

Congressman L. T. McFadden, of Pennsylvania, gave notice in the House on January 23 that further federal reclamation of arid land would be opposed, in the interests of farm relief. The argument is that competition of land on federal irrigation projects, which are heavily subsidized by the government, reduces the profit margin of unsubsidized farming, and is therefore objectionable under present conditions. Even on the subsidized land the government is not able to find settlers for all of the available farms, and although the government charges no interest and defers the period of repayment ever farther, there is small likelihood that its investment on reclamation work will be returned to the Treasury.

Lake Okeechobee Flood Control Discussed by Army Engineers

Proposed flood-control improvements for the Lake Okeechobee district of Florida were discussed before the House committee on flood control Jan. 23 by Col. Mark Brooke, divisional engineer of the Army Corps of Engineers, stationed at New Orleans. One plan is to divert the flow of the Kissimmee River to the Atlantic Ocean before it gets to Lake Okeechobee. Most of the lake's water comes from the Kissimmee. This plan would dispense with provisions for the Caloosahatchie outlet. Colonel Brooke stated that it is also proposed to increase the outlet discharges of the lake and to build larger and higher levees on the north and south shores.

A. F. Robinson, Noted Bridge Engineer, Is Dead

Albert Fowler Robinson, prominent as a bridge engineer and for 33 years bridge engineer of the Atchison, Topeka & Santa Fe Railway System, died at his home in Oak Park, Ill., on Jan. 20. Mr. Robinson was born at Henry, Ill., Oct. 12, 1854. He graduated from the University of Illinois in 1880, and in 1881 he took a post-graduate course on bridge engineering. In 1890 the university conferred on him the degree of Civil Engineer.

Mr. Robinson's first railway experience was as a chainman on the Denver & Rio Grande Railroad, in 1881, before taking his post-graduate course. He became an assistant bridge engineer on the Chicago & Alton Railway in 1882, and in 1883 went to the old bridge building firm of Kellogg & Maurice, at Athens, Pa. He was bridge engineer on the Atchison, Topeka & Santa Fe Railway in 1884, and on the Chicago, Burlington & Quincy Railroad from 1885 to 1889, after which he was engaged with the late E. L. Corthell and then with Purdy & Phillips, engineers, at Chicago. In 1892 he was assistant engineer on the Chicago, Rock Island & Pacific Railway, and from 1894 to 1896 in private practice. In 1896 he was appointed bridge engineer of the Atchison, Topeka & Santa Fe Railway System and retained this position until his death.

Mr. Robinson's latest notable work was the design of the Santa Fe railway's new double-track bridge over the Mississippi River at Fort Madison, Iowa, having a swing span 532 ft. long and carrying an upper deck for highway traffic. This bridge, with four 270-ft. double-deck fixed spans and steel viaduct approaches, was completed in 1927. In addition to his activities on bridge design, construction and renewal he designed a type of center-bearing turntable having 120-ft. through pony trusses. Several of these were built and installed by the railway.

Mr. Robinson was a member of the American Society of Civil Engineers and the Western Society of Engineers.

Wheeling & Lake Erie Ordered to Abandon Cleveland Station

The Interstate Commerce Commission has ordered the Wheeling & Lake Erie Railroad to discontinue temporarily the use of its Ontario St. station in Cleveland on account of the unsafe condition of the station being a possible public hazard. The W.&L.E. will use the Superior Ave. station and tracks of the Erie Railroad and the tracks of the C.C.C.&St.L. until the I.C.C. acts on the Wheeling application for permission to enter the new Union terminal. The city of Cleveland has refused to issue a permit for repairing the old depot.

Four Cities to Sell Improvement Bonds in February

Among current public bond offerings, some of which are listed in the accompanying tabulation, is $16,363,000 worth for the cities of Newark, East Orange, White Plains and Buffalo. The Newark sale, March 6, consists of $10,200,000 4½s, of which $3,000,000 is for the city's share of the Wanaque aqueduct, and $1,000,000 for schools. The previous long-term financing was in December, 1927, when $7,300,000 4½s brought a premium, the interest cost to Newark being 4.08 per cent.

East Orange on Feb. 11 offers $2,754,000 4½s as follows: $1,650,000 general improvement, $572,000 school, $532,000 Passaic Valley sewer bonds.

White Plains on Feb. 11 offers $2,815,000 to mature from 1932 to 1963. The rate, not to exceed 4½, will be bid on the obligations.

Feb. 6 Buffalo will be in the market for open bids on $594,000 4½s, part long and part short term. Of the total, $330,000 is for general improvements, maturing 1930 to 1959, and $264,000 for local, 1930 to 1933.

RECENT PUBLIC BOND OFFERINGS

	Amount	Interest	Yield
Asheville, N. C.	$2,590,000	5	4.60
Euclid, Ohio, school	100,000	6	5
Irondequoit, N. Y., sewers	256,000	5	4.55
Kansas City, Mo.	1,500,000	4½	
Tennessee, park	1,500,000	4½	4½
Trenton, N. J.	1,824,000	4½	4.25@4.10
Yonkers, N. Y.	2,050,000	4½ & 4¼	4.50@4.10
Province of British Columbia	6,417,000	4½	4.80

West Coast Lumbermen Condemn Price Cutting

At a recent meeting of West Coast lumbermen in Tacoma maintenance of firm prices was urged. Price fluctuations and price cutting, it was said, have reduced since 1923 the annual returns to the industry by $30,000,000.

Production of the mills of Washington, Oregon and British Columbia for the week of Jan. 19 was less than the average for the preceding three weeks. Orders exceeded production by 13.52 per cent, with shipments 13.27 under the week's production of 170,000,000 ft.

Bureau of Water Supply of Baltimore Reorganized

Charles F. Goob, chief engineer of Baltimore, has completed reorganization of the bureau of water supply, one of the divisions of the Department of Public Works of the city. Under the new plan the bureau is divided into seven units, each with its own head, and D. Benton Biser has been designated as assistant water engineer. The engineering unit of the bureau has been placed in charge of J. S. Strohmeyer. The other units and those in charge are: maintenance, J. B. Kaufman; construction, C. A. Warren; filtration and dams, James W. Armstrong; pumping stations, G. H. Leverton; service, W. C. Thayer, and executive, Cleon L. Rector.

River Survey Bill for Flood Control Passes Senate

A House bill authorizing the Secretary of War to make preliminary surveys of streams in sixteen states to determine possibilities of flood control has passed the Senate. The streams to be surveyed are as follows:

West branch of Susquehanna River, Pennsylvania; Auglaize, Blanchard and Ottawa rivers and their tributaries, and Saint Mary's River, Ohio; Kootenai River, Idaho; Mouse River, North Dakota; Black River, Arkansas; Mud River, Kentucky; Lumber, Little Pee Dee and Lynch's rivers, South Carolina; Mayfield Creek, Kentucky; Missouri River, near Elk Point, South Dakota; Salmon River, Alaska; Choctawchee River and its tributaries, Florida and Alabama; Brazos and Colorado rivers and their tributaries, Texas; Rough River, Kentucky; Canadian River and its tributaries, New Mexico; Roanoke, James and Staunton rivers, Maryland, and Yellowstone River, Montana.

Research Filtration Plant Under Construction at Ottawa

The city authorities of Ottawa, Ont., are constructing a research filtration plant at an estimated cost of $10,000 preparatory to the design of a working plant to serve the entire city. Bonds to the amount of $1,315,000 were authorized by the ratepayers on Dec. 3 by a vote of 7,294 for to 1,648 against. The general scheme has been approved by the Provincial Department of Health. The plant will be located on Lemieux Island in the Ottawa River and water for filtration will be drawn from that stream. The city has retained Gore, Nasmith & Storrie, of Toronto, to act with Commissioner of Works A. F. Macallum in the operation of the experimental filter and in the design, construction and putting into operation of the working filter plant. While the experiments are under way, work will be conducted on the major scheme.

McLean Contracting Company Joins Merritt-Chapman & Scott

Effective Jan. 1, the McLean Contracting Company, of Baltimore, for many years a prominent factor in the construction business of the East, was acquired by the Merritt-Chapman & Scott Corporation, marine contractors and ship salvors of New York, it was announced by William H. Baker, president of the latter concern. The new ownership involves all outstanding contracts, good will and use of the McLean name, as well as the physical property and equipment. The Baltimore headquarters of the McLean company will operate as a unit of the parent company, under the general charge of O. B. Coblentz and Frank B. Beasman, formerly president and vice-president respectively of the McLean Contracting Company.

Leslie Ames Becomes Louisiana State Highway Engineer

Leslie R. Ames, state highway engineer and acting highway commissioner of North Carolina, has resigned, to take effect Feb. 1, to become state highway engineer of Louisiana. During the ten-year period Mr. Ames was with the North Carolina highway department more than $150,000,000 was spent by the state in the construction of permanent highways. Louisiana is launching a hard-surfacing road program with an initial expenditure of $45,000,000 which will come under his direct charge.

Mr. Ames joined the North Carolina highway department in 1919 as draftsman and progressed to the position of chief engineer, acquiring that position Jan. 1, 1926. Previous to 1919 he was with the New York state barge canal, the New York State highway department, New York State Railways and the Southern Power Company. He is a graduate of Clarkson College of Technology, class of 1912.

20,000-M.G. Reservoir Proposed for Hartford

The Water Board of Hartford, Conn., has proposed building a dam to form a 20,000-m.g. storage reservoir on the Farmington River. The project, which includes a possible lease for a hydroelectric plant, has not yet been authorized by the Board of Aldermen or the State Legislature. C. M. Saville is manager and chief engineer of the water board.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Jadwin Plan Condemned by West Bank Interests—Nicaraguan Canal Route Survey to Be Considered

THE Jadwin plan for the control of floods on the Mississippi River is condemned by L. T. Berthe, representing west bank interests in Missouri, Arkansas and Louisiana, as "unsafe, economically unbalanced and unsound." The west bank interests are to ask for a review of the plan by outside engineers and have called upon American Engineering Council to make such a recommendation to President-elect Hoover.

In presenting the matter to Engineering Council Mr. Berthe contends that the Jadwin plan "never has been reviewed by unbiased authority, is deficient and dangerous, ignores fundamental known data, contains factors of safety both negligible and uncertain and omits all consideration of potential values and indirect costs."

President Berresford of Engineering Council has passed upon the Berthe proposal and finds that the subject matter comes fairly within the purview of the council and has referred it to the organization's flood-control committee, of which Gardner S. Williams, John R. Freeman, Arthur E. Morgan and Baxter L. Brown are the members.

Nicaraguan Canal Survey

By making the Nicaraguan Canal resolution third in the order of its unfinished business, the Senate has made it virtually certain that action will be taken on the measure this session. Several weeks ago the Edge resolution providing for a re-survey of the Nicaraguan Canal route encountered temporary obstruction on the floor of the Senate by Middle Western Senators who expressed the fear that the measure paved the way for further gains in commerce by the seaboard at the expense of the interior.

Senator Edge after studying the situation, however, believes that no serious opposition is to be expected from the Mississippi Valley Senators after they have been assured of the continued development of the inland waterways. It was indicated by those who led the opposition previously that their main purpose in blocking the bill was to force the issue of inland waterway development. According to those following the situation, there is every reason to believe that the greater part of the Congressional delegation from the Middle West realize that with the extension of the inland waterway system the advantages of the Panama Canal are being brought to the interior.

Hydraulic Laboratory

That Chairman Dempsey of the rivers and harbors committee is not disposed to expedite the hearings on the hydraulic laboratory bill was evident at the opening session of the rehearing held Jan. 29. Col. Edward M. Markham testified as to his observations at hydraulic laboratories in Europe. He said the tendency there is away from small-scale models under a roof and toward field work on a larger scale. He admitted that the science of hydraulic engineering is much more advanced in Europe than it is in this country. When proponents of the bill testify, they will take issue with Colonel Markham's statement about the trend away from the laboratory in Europe. They will present their side of the case only briefly so as not to contribute to what they think is an effort to prolong the hearings needlessly.

Colorado River Power Permits

An extension of the law precluding the issuance of water-power permits or licenses on the Colorado River was approved by the Senate Jan. 26. This resolution excepts the Gila River and its tributaries and makes the order effective until the Boulder dam act becomes effective.

Denver Calls for Bids on 8-Mile Water Conduit

Bids for a proposed 8-mile water conduit estimated to cost approximately $2,000,000 have been called for by the city of Denver, to be opened Feb. 11. The project is known as No. 13 conduit and will extend from Wynetka to South University Blvd. and East Jewell Ave.

Sealed proposals are asked on steel or precast reinforced-concrete pipe. Under the specifications, both steel and concrete will be used.

The advertisement for bids divides the conduit into two sections. One section, 21,198 ft. long, is to be constructed of 8,459 ft. of steel, 4,250 ft. of concrete and 8,489 ft. of steel or reinforced concrete. Bids will be received on 60-in. riveted or 58-in. hammer-weld, lock bar or automatic electric arc-welded steel pipe, and on 54-in. precast concrete pipe.

The other section will consist of 4,730 ft. of steel, 2,150 ft. of concrete and 15,783 ft. of steel or concrete. Bids will be considered on 66-in. riveted or 64-in. hammer-weld, lock bar or automatic electric arc-welded steel pipe and on 60-in. precast concrete.

Personal Notes

ELLIS CLARKE SOPER announces resumption of the practice of his profession of consulting engineering, with offices at 17 East 45th St., New York City.

FRANK H. NYGREN, construction engineer, of Detroit, is now sales engineer for the Bethlehem Steel Company in the State of Michigan, with headquarters in Detroit.

J. H. COLEY, Denver engineer, has joined Charles M. Johnstone at Espanola, N. M., on concrete dam work.

CHARLES MACA. WILLCOX, of Denver, second vice-president of the Moffat Tunnel Commission, has been appointed acting head until the vacancy caused by the death of William P. Robinson is filled.

MAX LOEFFLER, formerly with E. J. Van Antwerp, of Detroit, Mich., as chief engineer on land surveys, subdivision development and construction work, is now resident engineer on roads, canals and canal structures for the Hidalgo County (Texas) Water Control and Improvement District No. 6, with headquarters at Mission, Tex.

HARDY D. FERGUSON announces that he has admitted MOSES HAY TEAZE and JAMES WALLACE TOWER to partnership and that under the name Hardy D. Ferguson & Company and with offices at 200 Fifth Ave., New York City, they will continue the practice of consulting engineering, specializing in the design of pulp and paper mills and other industrial developments, steam and hydro-electric power plants and hydraulic structures of all kinds.

I. E. RUSSELL, of Cheyenne, has been appointed materials engineer of the Wyoming State Highway Department, succeeding W. A. NORRIS, resigned.

NEAL W. KNIGHT, consulting engineer, of Louisville, Ky., and W. A. MUELLER, formerly assistant city engineer of West Palm Beach, Fla., have formed the firm of Knight & Mueller, civil and hydraulic engineers, with offices in Louisville.

ARTHUR W. DEAN, since 1919 chief engineer of the division of highways in the Massachusetts Department of Public Works and previously chief engineer of the Massachusetts Highway Commission, has been appointed chief engineer of the Massachusetts Department of Public Works, which now includes the former division of highways and the division of waterways and public lands.

THOMAS E. MURRAY, for many years general manager, senior vice-president and vice-chairman of the board of directors of the New York Edison Company and an official and director of several other electric utility companies of Greater New York and Westchester, has recently severed these connections and intends to devote his time to Thomas E. Murray, Inc., designing and consulting engineers, of which he is president, and to the development of his patents. Thomas E. Murray, Inc., announces that it has moved its New York offices to 88 Lexington Ave. and that it has opened an office in the Eaton Tower Building, Detroit, Mich.

ARTHUR L. REEDER, formerly connected with the Philadelphia Filtration Bureau, Baltimore City Water Department, Pennsylvania State Department of Health, and recently in charge of design and construction of water-supply and filter-plant installations, has become principal assistant engineer for H. Burdett Cleveland, consulting sanitary engineer, of New York City.

OREN THOMAS, architect, of Des Moines, Iowa, has joined the firm of Proudfoot, Rawson & Souers. The new firm name is Proudfoot, Rawson, Souers & Thomas, and offices will be maintained in the Hubbell Building, Des Moines.

BARNEY HODGEN, of Phoenix, Ariz., has been appointed county engineer of Maricopa County, Arizona.

PIERRE FRANCK, chief engineer of the French Department of Aeronautics, has arrived at Montreal, where he will deliver a series of lectures at McGill University and other institutions of learning, dealing with the development of aviation since the war.

E. C. NELSON, for the past two years at the head of the engineering department of the Longview Fiber Company, Longview, Wash., has resigned and will enter the engineering and construction firm of O'Keefe & Orbison in Appleton, Wis.

Brief News

A BILL PROVIDING for the construction of a public aviation field on Governors Island, New York Bay, has been introduced in Congress. The intention is to provide a loading and discharging point for passengers and freight near the center of the metropolitan area. No provision would be made for terminal facilities for planes.

AVERAGE COMMODITY PRICES for the country last week advanced 0.6 per cent to 97.8 per cent, compared with 100 in 1926 and yearly averages of 94.2 for 1927 and 69.8 for 1913, according to Irving Fisher's weekly index.

PROCEEDINGS FOR ACQUIRING the last two toll bridges remaining over the Delaware River between New Jersey and Pennsylvania have been begun by the joint committee for the elimination of toll bridges. Condemnation actions will be made against the two bridges, located at Delaware, Pa., and at Dingman's Ferry, Pa.

AUTHORITY FOR THE JOINT purchase with the State of Virginia of the two highway toll bridges across the Potomac River at Point of Rocks and Brunswick, Md., is asked in a bill presented to the Maryland House of Delegates. The bill provides that the bridges be operated on a toll basis by the states until paid for and then be made free crossings.

CONSTRUCTION OF A BRIDGE over the St. Lawrence River near Morristown, N. Y., was reported favorably to the House of Representatives by the interstate commerce committee on Jan. 23. The project has already met with the approval of the Canadian government and a charter was granted at the last session of the Dominion Parliament. Present plans call for a bridge for vehicle traffic only, at an estimated cost of $7,000,000.

PLANS FOR THE CONSTRUCTION of a new highway along the East River front in New York from South St. north to 54th St. have been submitted to the Board of Estimate by Borough President Miller.

CONSTRUCTION IS UNDER WAY on the first railroad on the island of Bermuda, connecting Somerset and St. George with Hamilton. The road will be completed by June.

A 16-MILE TUNNEL has just been completed in northern Korea as the first unit of a power development. The tunnel will divert eastward into the Sea of Japan a large stream which has hitherto flowed north into the Yalu River. The ultimate capacity of the power project will be 102,000 kw., all of which will be used to run a nitrogen plant manufacturing fertilizer, at the city of Kanko.

LOUISVILLE, KY., has retained Harland Bartholomew and associates, of St. Louis, to present a comprehensive city plan and zoning system for the city.

Engineering Societies

CALENDAR

Annual Meetings

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; annual convention, Detroit, Mich., Feb. 12-14.

ENGINEERING INSTITUTE OF CANADA, Montreal, Que.; annual general and general professional meeting, Hamilton, Ont., Feb. 13-15.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; annual convention, Chicago, Ill., Feb. 18-22.

NATIONAL DRAINAGE CONGRESS, Kansas City, Mo.; annual convention, Memphis, Tenn., Feb. 19-21.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago; annual convention, Chicago, March 5-7.

* * *

THE FOURTH ANNUAL SOUTHWEST ROAD SHOW AND SCHOOL will be held in Wichita, Kan., Feb. 26 to March 1.

THE CHICAGO ASSOCIATION OF CONSULTING ENGINEERS, at its ninth annual meeting on Jan. 21, elected officers as follows: Ernest V. Lippe, president; Rollo E. Gilmore, vice-president; H. L. Clute, secretary-treasurer. This association consists of professional engineers engaged in mechanical, electrical and sanitary engineering who are in no way connected with or interested in the sale of equipment or apparatus.

THE AMERICAN SOCIETY OF CIVIL ENGINEERS, Los Angeles section, held its regular monthly meeting Jan. 9 under the direction of the recently elected officers for the coming year, who are: Walter E. Jessup, president; A. F. Barnard and E. R. Bowen, vice-presidents; O. A. Stone, secretary, and R. L. Anderson, treasurer. Dr. Walter Dexter, president of Whittier College, gave an address on the "Philosophy of Life" and L. T. Eliel, of the Fairchild Aerial Surveys, presented the technical paper on the development and methods of aerial mapping.

THE AMERICAN SOCIETY OF CIVIL ENGINEERS, Portland (Ore.) section, at its annual meeting on Jan. 9, elected the following officers for 1929: C. P. Dunn, president; C. C. Hockley, vice-president; C. F. Thomas, secretary. The speakers of the evening were C. F. Swigert, president of the Pacific Bridge Company, who discussed the harbor wall being built along the Willamette River in Portland; J. C. Stevens, who described the Leaburg power project for the city of Eugene, Ore., and R. F. Hoffmark, who spoke on the methods of construction and difficulties encountered in the Cascade tunnel.

THE CONNECTICUT SOCIETY OF CIVIL ENGINEERS will hold its annual meeting in Hartford Feb. 19 and 20. Clarence M. Blair, New Haven, is secretary.

THE HIGHWAY ENGINEERS ASSOCIATION OF MISSOURI will hold its 1929 meeting in St. Louis, Feb. 12-14. Plans will be discussed for developing the state's roads under the $75,000,000 bond issue passed at the last election.

THE COLORADO SOCIETY OF ENGINEERS held its first annual convention on Jan. 19, at the Albany Hotel, Denver, Colo., President Oliver T. Reedy presiding. Papers were read by M. C. Hinderlider, state engineer; F. F. McCammon, assistant superintendent of the Public Service Company of Colorado; G. F. Loughlin, chief engineer of the United States Geological Survey; Frank E. Shepherd, director of the Denver mint; D. J. McQuaid, consulting engineer. At the banquet in the evening Gov. Frank C. Emerson of Wyoming, who is a civil engineer, was the principal speaker. His subject was "The Engineer as an Executive."

THE NASHVILLE ENGINEERING ASSOCIATION has announced the personnel of its special committees for 1929, and these committees are now actively at work. The association has indorsed the recommendation of the municipal buildings committee that the engineers take steps toward getting a new municipal auditorium for Nashville.

THE CHICAGO REGIONAL PLANNING ASSOCIATION will hold its annual meeting Feb. 5. The secretary is Robert Kingery.

THE NATIONAL DRAINAGE CONGRESS will hold its eighteenth annual meeting at Memphis, Tenn., Feb. 19-21. Among the principal subjects for the program are the following: "Flood Control on the Yazoo and Drainage of the Delta Lands of the Mississippi," Jacob A. Harman, consulting engineer, Peoria, Ill.; "Rehabilitation of Levee Districts," B. F. Williams, State Reclamation Engineer, Austin, Tex.; "Effect of Drainage on Forest Growth," E. V. Willard, State Commissioner of Drainage, St. Paul, Minn.; "The South Canadian River and Its Relation to Mississippi River Flood Control," A. Hurley, State Flood-Control Commissioner, Tucumcari, N. M.; "Effect of Brush on Discharge of Streams and Drainage Ditches," S. H. McCrory, U. S. Bureau of Public Roads, Washington, D. C.; "The Financial Status of Drainage Districts," C. H. Young, consulting engineer, Muscatine, Iowa; "The Case for the Tributary Rivers," E. E. Blake, Oklahoma City, Okla.; "Settling Interstate Problems by Compact," A. S. Stinnet, member of the Arkansas River Conference, Amarillo, Tex.; "Industries in Relation to Drainage and Flood Control," William Crooks, industrial engineer, Little Rock, Ark.; "Utilities in Relation to Drainage and Flood Control," J. G. Holtzclaw, Gulf States Utilities Company, Beaumont, Tex.; "Silting," E. A. Rossiter, consulting engineer, Chicago; "Flood Control on the Smaller Streams by Reservoirs," James A. Rhyne, civil engineer, Corning, Ark. The president is A. W. Large, agricultural agent of the Rock Island Lines, Chicago; secretary, L. J. Smith, Kansas City, Mo.

Cost and Contracts

E. N.-R. Index Numbers

Cost		Volume	
Jan. 1, 1929	**209.40**	**December, 1928**	**244**
Dec. 1, 1928	210.16	November, 1928	251
Jan. 1, 1928	203.90	December, 1927	319
Average, 1928	206.78	Average, 1928	287
Average, 1927	206.24	Average, 1927	263
1913	100.00	1913	100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended Jan. 29, with some comparisons, total as follows:

(In Thousands of Dollars)

	Jan. 29, 1929	Jan. 22, 1929	Jan. 31, 1928
Building:			
Industrial	$8,339	$1,355	$2,953
Commercial	17,446	35,780	28,316
Streets and roads	4,889	6,918	12,588
Other eng. constr.	21,328	21,712	4,806
Total	$52,002	$65,765	$48,663
Total, all classes, Jan. 1 to Jan. 29:			
1929			$397,322
1928			251,646

Obituary

FRANCIS CLOPPER HUTTON, 65, a civil engineer and one of the members of Maryland's first Good Roads Commission, died on Jan. 20 at his home in Montgomery County. Death was due to pneumonia. Mr. Hutton studied his profession at Rensselaer Polytechnic Institute, Troy, N. Y. He was the son of the late William R. Hutton, who for many years was vice-president of the American Society of Civil Engineers.

WILLIAM PRESTON BROWN, 87, who served three terms as city engineer of Columbus, Ohio, and county engineer for one term in that state, died in Los Angeles, Calif., on Jan. 6.

GEORGE FETTER STICKNEY, who designed the locks and dams of the New York state barge canal, died at his home in Albany on Jan. 27, in his 60th year. Mr. Stickney was graduated from Yale University in 1891 and served as captain in the Spanish-American War. He was a member of the American Society of Civil Engineers.

CHARLES P. HENWOOD, civil engineer, of Toronto, Ont., died on Jan. 20 at the age of 51. He was for some years associated with Ross & MacDonald, engineers and architects, of Montreal, and had charge of the construction of many important public and commercial buildings in that city and Toronto.

MICHAEL KENNEDY, 52, superintendent of construction for the Colorado Highway Department, died in Denver on Jan. 22.

WILLIAM P. TIERNEY, pioneer railroad builder of the Pacific Northwest, died Jan. 26 at Vancouver, B. C., at the age of 75.

A. WARD MORRIS, former city engineer of Roanoke, Va., died there Jan. 17.

WILLIAM H. CHAPMAN, 72, a member of the New York civil engineering firm of Waring, Chapman & Farquhar, died on Jan. 28 at his home in Harrison, Me.

Equipment Advancement Recorded at 1929 Road Show

Engineering News-Record Staff Report

PART II

THE 1929 Road Show in Cleveland, Jan. 14 to 18, was by far the largest yet held, 406 organizations maintaining exhibits. In Part I of this report of the show, published last week, the equipment incidental to grade preparation, paving and surfacing was described. The concluding chapter of the report which follows, considers equipment used in the transportation of roadbuilding materials, equipment which contributes to better highway operation service, and the important miscellaneous exhibits which showed fabricating parts and small tools. In addition there immediately follows a paragraph on bituminous equipment for which space was not available last week.

Bituminous Equipment—Bituminous equipment consisting principally of pressure distributors, asphalt heaters, tool heaters, portable asphalt patching plants and heating vessels were exhibited. Littleford Bros., Inc., showed its Model 83 oil-burning tar and asphalt kettle with a new combustion chamber of special composition steel and "Sil-O-Cel" insulation. This company also showed a new steel tool box and a hand spraying attachment for use with distributors. Chausse Oil Burner Company exhibited its self-propelled Model E-3 portable asphalt plant. Literature on asphalt plants was shown by the J. D. Farasey Manufacturing Company and by the F. D. Cummer & Son Company. Pressure distributors were exhibited by the Good Roads Machinery Company, Charles Hvass & Company (also showing asphalt kettles and tool heaters), the N. V. Hendricks Company and E. D. Etnyre. The latter company also exhibited a new trailer type tank car heater consisting of double boilers, two burners, fuel tank, pressure tank, condensate pump, flexible steam connections and necessary valves and other appliances. It is claimed to be a matter of only a few minutes for one man to set it up and have 125 lb. of steam in the coils. The Burch Corporation exhibited an asphalt spreader for trailer attachment to a motor truck. Other exhibitors were the Mohawk Asphalt Heater Company and the Macleod Company. The Good Roads Equipment Corporation exhibited its "Greco" asphalt pavement heater.

Transportation of Materials

The modern trend toward increased mobility of construction equipment and improved facilities for transporting materials was much in evidence. Truck manufacturers are catering to the roadbuilding needs of the industry. Each year sees new types of bodies for truck and trailer use, and inventive minds are constantly turning out new improvements on body hoists. Crawler equipment continues to advance in size, variety and number.

Trucks — Practically every motor truck exhibited had been improved in some detail. None of these changes was radical, but all were made with a view toward longer life and more efficient operation. Perhaps the most unusual truck design was shown by the Cleveland Crane & Engineering Company, which exhibited a "Cant-Rut roller truck" utilizing a rear wheel bearing surface of six tires rather than the conventional two. It is claimed that the two three-tired wheels, which form almost a solid roller across the rear of the truck permit its operation on a subgrade without damage. Rolled steel is used in place of cast steel in the wheels to reduce the weight of the rear axle unit to only slightly more than that of the ordinary rear axle assembly. The unit was shown mounted on an International truck, resulting in a front-wheel chassis weight of 3,750 lb. and a rear-wheel chassis weight of 6,500 lb.

A four-wheel drive truck featuring easy steering by means of a patented cam and lever arrangement and having available eight speeds forward and two reverse was shown by the Coleman Motors Corporation. The Freeman Motor Company also exhibited a four-wheel drive truck on which special axles are used to carry the load, relieving the power-carrying members of all weight. By means of a new beveled design front-steer drive running in oil, this truck is also said to solve the difficult steering problem of four-wheel drive trucks. The Relay Motors Corporation exhibited 2- and 3-ton models using its system of two rear axles, a fixed axle carrying the wheels and a "floating" axle to which the power is applied. The Dodge Brothers Corporation exhibited trucks for the first time under its own name; although it has always manufactured the trucks, it has used the name of Graham Brothers. The new 3-ton model shown marks the entry of Dodge Brothers into the heavy truck field. The Republic Sales Corporation exhibited its 3½-ton Republic truck and a Linn tractor truck, the rear crawler unit of which was mounted on a revolving mechanism of irregular contour to illustrate its flexibility. The O'Connell Motor Truck Company exhibited its two-way drive truck with dual control.

On the trucks of the Selden Truck Corporation, a 4-ton seven-speed model and a 2-ton four-speed model, special "helper" springs mounted on top of the usual rear springs are claimed to give the machines longer life and easier riding qualities. The Chevrolet Motor Company exhibited its new six-cylinder truck with various types of dump bodies up to 1½-ton capacity. The Pierce-Arrow Motor Car Company exhibited its trucks at the Road Show for the first time, the exhibit featuring a 2-yd. six-cylinder 70-hp. dump truck with 140-in. wheelbase. Other truck exhibitors were as follows:

LeBlond-Schacht Truck Company, Ford Motor Company, International Harvester Company, White Company, Federal Motor Truck Company, Four-Wheel Drive Auto Company, Autocar Company, Diamond Truck Company, Larrabee-Deyo Motor Truck Company, American Aggregates Corporation, Maccar Truck Company, Reo Motor Corporation.

Bodies and Body Hoists—The most important development in the field of truck bodies was centered around ready-mixed concrete practice. Seven manufacturers showed ready-mixed concrete bodies in as many designs. The Clinton Motors Corporation exhibited one of its revolving tank bodies. Several of these, both in the 2-yd. and in the 3-yd. size, also were shown by truck manufacturers. The inside walls and ends of this tank body are perfectly smooth. In operation the mixed concrete is loaded, the tank is hermetically sealed and slowly revolved until ready for discharge. Power for revolving the tank is furnished by a two-cylinder 8-hp. engine placed between the cab and the body. The C. O. Bartlett & Snow Company exhibited a body with movable side plates designed both for mixed concrete and for general material haulage purposes. In hauling ready-mixed concrete the movable sides are brought together at the bottom, forming a "V." When the truck arrives at the job, the sides are moved back to their vertical position, dropping the concrete to the floor and thus furnishing a remixing action to counteract any segregation that has taken place in transit. When used for general haulage purposes the movable sides are of course held in the vertical position.

A body which remixes concrete as it is dumped was shown by the Hug Company. As the front of this body is raised the upper shell of the body leaves the lower half, forming a chute for the concrete. The falling motion of the concrete, coupled with the fact that there are cross-members in the body over which it tumbles, is claimed to remix it thoroughly. The new Blaw-Knox "Agitator" body shown was semi-circular in cross-section and contained a series of blades mounted on a longitudinal shaft, these blades being revolved by truck engine power through a power take-off. A hoist with an unusually high lift is used for the body so that concrete can be discharged into an elevated hopper suitable for feeding it to wheelbarrows or buggies. This body

is also said to be usable for general haulage purposes without removing the agitator mechanism, although this is easily removed whenever desired. The Wood Hydraulic Hoist & Body Company exhibited a new "bathtub" body with a semicircular cross-section, which is believed by the company to be the most efficient shape for hauling mixed concrete without segregation. A small, completely inclosed body was shown by the LeBlond-Schacht Truck Company. This was mounted transversely on the truck chassis and rotated by a chain drive to the truck's power take-off. The shape of the body resembles the ordinary drum mixer, although the body is smooth inside, the only obstruction being the supporting shaft.

Sidelights on the Show

TWO types of trucks are available for haulage from central mixing and batching plants—one designed to prevent segregation of wet concrete, the other actually to mix the dry-batched aggregates with water in transit.

A BELT conveyor in one truck body exhibited furnished the self-dumping mechanism usually provided by an under-body hoist.

The above-mentioned ready-mixed concrete bodies are designed solely for transporting mixed concrete. Three other manufacturers showed bodies which are in effect truck mixers—that is, the concrete materials are charged dry and water is added from a tank on the truck, mixing being accomplished en route or at the job. The Barrymore Concrete Mixer Corporation exhibited its open-top body mixer in which the mixing blades are rotated by a power take-off from the truck. With this body mixing is accomplished after the truck arrives at the job, although both the water and the dry-mixed cement and aggregate are carried on the truck. Transit Mixers, Inc., exhibited its revolving drum body in which flights and blades first mix the aggregate and cement dry and later at the job or in transit complete the mixing as the water from the truck tank is added. This tank has two compartments, a main supply and a reserve. A special feature of the operating mechanism is that it permits revolving the drum in either direction and at all positions, whether raised or lowered. The third truck mixer body was shown by the Truck Mixer Company, affiliated with the Jaeger Machine Company. This body, in shape a cylinder attached to a truncated cone at its rear end, also mixes the concrete en route, but is suitable for hauling ready-mixed concrete, gravel, sand or bulk cement. A feature of this body is that it is permanently fastened to the truck chassis and rotates in one direction to charge and in the opposite direction to discharge. It is built in 1, 2 and 3 cu.yd. sizes.

In the field of ordinary truck bodies, the Cleveland Crane & Engineering Company exhibited a unique model incorporating a belt conveyor bottom. One end of the belt is fastened to the front end-gate and the other to a roller placed across the rear end of the truck. As the belt is wound up on the roller by engine power the front end-gate is pulled to the rear of the body, bringing with it the load of materials, which is discharged over the roller. The body is completely electric arc welded.

The Galion All Steel Body Company exhibited gravity and hand hoist steel bodies utilizing a patented "rollback" mechanism by means of which the body travels backward about 20 in. on the sub-frame before the load is finally dumped. It is claimed to result in easier and quicker operation, at the same time to carry the weight of the load considerably ahead of the front axle. Three-way dump bodies were shown by the Differential Steel Car Company and by the Commercial Shearing & Stamping Company. The Anthony Company, Inc., exhibited a new line of dump bodies operating by means of a rotating power-driven hoist. A special body hoist in the form of an articulated rack run by a worm and gear power take-off was shown with the bodies of the Hercules Products Company.

Dump bodies were also exhibited by the Jungersen Dump Body Company, the Perfection Steel Body Company, the Marion Steel Body Company, the Superior Body Corporation and the Heil Company, which also exhibited a new single-cylinder body hoist. Truck cabs were exhibited by the Metropolitan Body Company and by the Highland Body Manufacturing Company, the latter mounted on rocker sills so that the cab remains on an even keel regardless of the pitch of the chassis. Body hoists were also shown by the Wood Hydraulic Hoist & Body Company and by the Hydraulic Hoist Manufacturing Company. The Gustav Schaeffer Wagon Company exhibited a double-worm truck winch to be used in handling loads on and off trucks. With this winch the drum and niggerheads can be run in opposite directions if necessary.

Tractors — The complete lines of crawler tractors shown encompassed all models, from those designed for such work as golf course construction and maintenance to those capable of pulling trains of heavy dump wagons and operating huge snow plows. The Caterpillar Tractor Company, in addition to its 2-ton and its "20," "30" and "60" models, showed a new "10" machine. The Monarch Tractors Corporation, now a division of the Allis-Chalmers Manufacturing Company, exhibited its models "50" and "75" and in addition a new "35," which lists among its new features an ordinary truck-type steering wheel. Other crawler tractors were exhibited by the Cleveland Tractor Company, the International Harvester Company and the Bates Manufacturing Company. The Hughes-Keenan Company exhibited its "Iron Mule" tractor in a new 4-yd. body size, the whole mounted on crawlers and equipped with a power hoist, allowing accurate control of the body both in dumping and in bulldozing work. A somewhat similar unit but mounted on ordinary wheels was shown by the Winsor Company, a feature of which was a patented front axle which is claimed to keep the wheels in upright position regardless of the inclination of the axle.

Trailers — The most important development in trailers shown at the Road Show was the extended use of crawler units, particularly on the larger units. All of these trailers are of steel construction throughout. The A. Streich & Brothers Company exhibited a new 12½-yd. dump wagon trailer with crawlers on both the front and the rear axles. The Athey Truss Wheel Company exhibited a new tractor trailer fitted with a three-way dump body hydraulically operated by the tractor driver. A 9-yd. bottom dump wagon with crawlers front and rear in which the action of the doors was controlled by cables operated by hydraulic power from the tractor was shown by the LaPlant-Choate Manufacturing Company, Inc. The Austin-Western Road Machinery Company exhibited a new 5-yd. crawler wagon similar to its 7- and 10-yd. units, and the Euclid Crane & Hoist Company showed a new bottom dump crawler wagon of 5½-yd. capacity with the door-lifting mechanism mounted on Hyatt roller bearings.

Other crawler trailers were exhibited by the Biehl Iron Works, Inc., and by the Smith Trailer Company. Heavy-duty trailers suitable for hauling construction equipment were shown by the Fruehauf Trailer Company, the Rogers Brothers Corporation, the Winsor Tractor Equipment Corporation and Charles Hvass & Company. Whitehead & Kales exhibited a four-wheel trailer wagon with stake body.

Locomotives — Four manufacturers exhibited industrial locomotives. The Fate-Root-Heath Company, in addition to its 5- and 8-ton gasoline outfits, showed a 25-ton diesel locomotive. The Cincinnati Car Corporation, a new company in the industrial locomotive field, showed a new geared gasoline locomotive. The Midwest Locomotive Works featured its gear-driven gasoline locomotive equipped with an underslung one-piece manganese steel casting frame, and the Brookville Locomotive Company showed its 4- and 6-ton models built around the McCormick-Deering tractor and equipped with the company's new inclosed cab. Each of the models has three speeds forward and reverse.

Sidelights on the Show

DUMP bodies discharging toward the sides as well as to the rear are optional equipment on many trucks and one trailer.

CRAWLER equipped trailers are available in sizes from 5 to 20 tons.

Hoists and Cableways — The hoists and cableways shown were not materially different from previous models. The Lidgerwood Manufacturing Company exhibited a two-drum hoist driven by a spiral bevel gear rolling on Timken bearings. In the transmission case between the power unit and the hoist interchangeable gear sets with ratios from 1 : 4 to 1 : 40 are available to give rope speeds up to 1,000 ft. per minute or rope pulls up to 8,000 lb. on single line duty. The Clyde Iron Works Sales Company showed a double-drum gasoline hoist mounted on an arc-welded frame and equipped with a floor level indicator of the visible dial type on each drum. The hoist has been improved so that at no time is it necessary for the operator to stand. Double-drum hoists were also exhibited by the S. Flory Manufacturing Company and the National Hoisting Engine Company.

Models of slack line cableways and power drag scrapers were shown by the R. H. Beaumont Company and Sauerman Brothers, the latter also showing a new universal cableway bucket with manganese steel lip and removable manganese steel teeth. A 50-hp. two-speed slack line cableway hoist was shown by the O. K. Clutch & Machinery Company, and the Garst Manufacturing Company showed a power plow scraper inclosed with an adjustable top for operating under water and for varying the amount of load desired to be picked up. The Sterling Machinery Corporation also exhibited a two-drum gasoline hoist.

Engines—The many exhibits of gasoline engines at the show preclude mention of the improvements in detail. A unique engine shown by the New-Way Motor Company was a six-cylinder air-cooled unit weighing about 280 lb. and available in sizes of 6 to 10 hp. Both the Buda Company and the Atlas-Imperial Engine Company had exhibits of four-cycle diesel engines and benefited from the fact that other equipment at the show was equipped with their products. The Buda Company showed both a four- and six-cylinder model of its M.A.N. diesel, the six-cylinder model being in the 180-hp. size. These engines are started by means of a small auxiliary gasoline engine. On the Atlas-Imperial Engine Company's machine a compressor is utilized for starting purposes.

Fairbanks, Morse & Company exhibited a 60-hp. two-cycle diesel engine for road service, and the Page Engineering Company showed a new diesel engine claimed to be the only two-cylinder four-cycle horizontal diesel made for excavating and other heavy-duty purposes. It has a bore of 7½ in. and a stroke of 15 in. One-piece intake and exhaust valves of special design are claimed to insure efficient and uninterrupted service. The engine is also made in a larger size having a bore and stroke of 13 and 20 in. respectively.

Exhibitors of gasoline engines and power units included Climax Engineering Company, Continental Motors Corporation, Fuller & Johnson Manufacturing Company, Hercules Motors Corporation, Hercules Products, Inc., Le-Roi Company, Lycoming Manufacturing Company, Minneapolis Steel & Machinery Company, Novo Engine Company, Stearns Motor Manufacturing Company, Stover Manufacturing & Engine Company, Waukesha Motor Company, Wisconsin Motor Company.

Service Facilities

Such exhibits as snow-removal equipment, highway signs and signals, maintenance graders, shoulder machines and asphalt-patching plants represented equipment that contributes to the efficient operation of existing highways. The bituminous equipment and some of the maintenance machines have already been described.

Snow-Removal Equipment — Several new or improved machines were shown among the exhibits of snow loaders, the Good Roads Machinery Company featuring a blade-lifting device for snow plows operated by compressed air. The Rotary Snow Plow Company, in addition to its V-plow with rotary blades on each side used for blowing the snow from the roadway, showed a unit which is essentially one-half of its V-plow but with which the snow is blown into a spout which conveys it to the side of the road or into trucks. The Rightway Corporation showed a unique rotary snow shovel which is used as a supplement to a V-type plow, and consists of a boom mounted in front of the truck radiator and equipped at its outer end with a rotor having seven shrouded, trough-shaped shovels driven through a transmission by the vehicle engine. The boom, which is controlled from the driver's seat, may be swung to either side and raised or lowered to engage the snow. When not needed it may be swung to one side, permitting free operation of the V-blade. This company also showed a rotary blower for crawler tractor attachment. A special snow truck was shown by the Walter Motor Truck Company equipped with a V-plow in front and a scraper plow underneath. The Klauer Manufacturing Company exhibited a model of its snow truck which utilizes an auger to cut the snow and drag it to the center of the roads, where a blower blows it completely off the roadway.

Other V-type plows were shown by the Batavia Steel Plate Construction Company, the Maine Steel Products Company, showing the Sargent snow plow, and the Wausau Iron Works, showing its snow plow with mechanically operated wings mounted on a Caterpillar tractor. Snow loaders were shown by the N. P. Nelson Iron Works, the Haiss Manufacturing Company, the Barber-Greene Company and the Joy Manufacturing Company, the latter's machine differing from the first three in being a belt loader instead of a bucket loader and utilizing gathering arms instead of revolving cutters.

Signs and Signals—Signs and signals which reflect the rays of automobile headlights were shown by the Ray Signs Corporation, the National Colortype Company, the Redflex Signal Company and the American Gas Accumulator Company. The latter company also showed flashing beacons. The Wallace & Tiernan Company exhibted a flashing signal operating on dry batteries which it is manufacturing for sale by the National Carbon Company.

A new design in electric stop-and-go signals was exhibited by the National Traffic Signal Company. This signal presents a narrow vertical panel of red in two directions and green in the other two for a predetermined length of time, while during the last ten seconds of the interval a black indicator rises from the bottom to the top of each panel as a warning that a change is about to occur. The indicator on the red panels lags behind that on the green panels so that red panels are shown in all four directions for the necessary time to clear the intersection. The Metal Traffic Markers Corporation showed Monel metal buttons for insertion in pavements to mark traffic lanes. Rustproof road signs were shown by the Westman Company and the Snell Metal Sign Company.

The Toledo Pressed Steel Company showed its spherical oil-burning construction lights equipped with a new head, of which it is said that "the harder it blows the better it burns." A 50 per cent saving in oil and the practically complete elimination of wick replacement are said to be other advantages of the new head. Carbide was shown by the National Carbide Sales Company and the Prest-O-Lite Company, which also exhibited oxygen and carbide construction lights.

Miscellaneous Service Exhibits — Highway guard rail fence was exhibited by the Page Steel & Wire Company, the American Steel & Wire Company, the Cyclone Fence Company, the Anchor Post Iron Works and the American Wire Fence Company.

Wheel load scales for weighing trucks as used extensively by a number of highway departments and state police organizations were shown by the Black & Decker Manufacturing Company, and by Fairbanks, Morse & Company.

For road maintenance, under-truck scrapers were exhibited by the Willet Manufacturing Company, the Root Spring Scraper Company and the Pneu-Hydro Road Machinery Company. The latter scraper is hung from a circle which is attached to the truck frame blade, pressure being applied through a hydraulic mechanism and road shocks absorbed by an air cylinder. For spreading aggregate, sand and gravel, Highway Service, Inc., exhibited its "Big Sandy" aggregate distributor,

Sidelights on the Show

HIGH-SPEED diesel engines in both two- and four-cycle types are taking their place with gasoline and steam machines as industrial power units.

MACHINES and equipment for servicing highways are slowly developing.

which is a self-contained power-operated machine, and two new spreaders for trailer attachment behind a rear-dump truck. The Stolle Spreader Sales Company exhibited a sand and chip spreader for motor truck attachment, and the Goroco Mechanical Spreader Company and the Charles Hvass Company, Inc., showed revolving plate spreaders of their special designs. The Goroco spreader has been improved by the use of cast steel in place of cast iron. The Rawls Manufacturing Company exhibited mowing machines, one being a complete gas engine powered machine and another a tractor-hauled mower with power-operated sickles. The company also exhibited a heavy-duty highway mower of the axle drive type. The Elgin Corporation showed its motor sweeper and also a new catch-basin cleaner attachment for motor trucks.

For finishing the shoulders of highways, the Highway Shoulder Machine Company exhibited models of its machine which runs on the pavement and by means of adjustable blades reaches out to the edge of the shoulder. The Lakewood Engineering Company also exhibited a new shoulder construction and maintenance machine which gathers up the material from the ditch and completes the shoulder to exact templet, working both sides of the road at the same time either forward or backward. Traffic is allowed to pass over the center of the machine while it is in operation. The machine has a total width of 40 ft. but can be adjusted to 16 ft. for passing through bridges. It has full crawler mounting and a speed of 1 m.p.h. on construction and 2 m.p.h. on maintenance.

Miscellaneous Exhibits

Small Tools — In the field of small tools, shovels, spades and scoops were exhibited by the Ames Shovel & Tool Company, the Conneaut Shovel Company and the Baldwin Tool Works. Woodworking equipment was shown by the DeWalt Products Company and by the Jones Superior Machine Company. The Wappat Gear Works, Inc., exhibited its electric handsaw, and the Snap-On Wrench Company showed its special patented wrenches. Concrete carts and barrows were shown by the General Wheelbarrow Company, and in addition this company exhibited a new grader blade of special steel. The Chisholm-Moore Hoist Corporation exhibited electric and differential pulley hoists. Joseph T. Ryerson & Sons showed tools for metal working and the Alexander Milburn Company exhibited its gas welding and cutting torches as well as carbide operated construction lights.

Fabricating Equipment—Manufacturers who furnish many of the parts used in the modern construction machine were represented at the Road Show in larger numbers than ever before. The interest shown in this type of equipment is proof of the fact that contractors are vitally concerned with the mechanical and structural details of their machines. The following table gives the name and the general character of the exhibit of these manufacturers:

Alloy Cast Steel Company—steel castings.
American Bosch Magneto Corporation—magnetos.
American Manganese Steel Company—castings.
Robert Bosch Magneto Company—magnetos, fuel ignition system.
Broderick & Bascom Rope Company—wire rope.
Brown-Lipe Gear Company—transmissions and clutches.
Bunting Brass & Bronze Company—bushings and bearings.
Christie Crawlers, Inc.—crawler units.
Dayton Steel Foundry Company—trucks and bus wheels.
Eaton Axle & Spring Company—front and rear axles for trucks and buses.
Eisemann Magneto Corporation—magnetos.
Endicott Forging & Manufacturing Company—forgings.
Erie Malleable Iron Company—wheels for trucks and buses, including a new dual wheel for the Ford truck.
Fafnir Bearing Company—ball bearings.
Farrell-Cheek Steel Foundry Company—steel castings.
Ferry Cap & Set Screw Company — set screws.
French & Hecht—steel wheels.
Fuller & Sons Manufacturing Company—transmissions and clutches.
Gears & Forgings, Inc.—gears.
General Metal Wheel Company—wheels.
Gilbert Manufacturing Company—wide rubber-tired wheels for McCormick-Deering tractors.
Harwen Products Corporation—condenser for improving sparkplug efficiency.
Hazard Wire Rope Company—wire rope.
Hyatt Roller Bearing Company — roller bearings.
Leece-Nieville Company—electric ignition equipment for gas engines.
A. Leschen & Sons Rope Company—wire rope in round strand and flat strand construction.
MacLean Fogg Lock Nut Company—patented lock nuts.
MacWhyte Company—wire rope.
Morse Chain Company—silent chains and patented spring sprocket.
Motor Improvement, Inc.—"Purolator" oil filter.
New Departure Manufacturing Company—ball bearings.
Nugent Steel Castings Company—steel castings.
Park Drop Forge Company—forgings.
Perfex Corporation—radiators.
Russell Manufacturing Company — brake shoes and linings.
Simons Paint Spray Brush Company—air paint equipment.
Sivyer Steel Castings Company—gears and castings.
Staynew Filter Corporation—air filters.
S.K.F. Industries, Inc.—non-friction bearings.
Taylor-Wharton Steel Company — manganese steel buckets and castings.
Timken-Detroit Axle Company—four-wheel drive rear truck unit of special flexible design.
Timken Roller Bearing Company — roller bearings.
Titeflex Metal Hose Company—flexible hose.
Trackson Company — crawler units, bulldozer, shovel and crane for McCormick-Deering tractors.
Twin-Disc Truck Company—clutches.
Western Crucible Steel Casting Company—gears, bucket teeth and miscellaneous steel castings.
Western Metals Specialty Company — gas engine housings of sheet metal.
Williams Alloy Products Company—metallic packing for shafts.
Williamsport Wire Rope Company — wire rope and machine showing method of manufacture.
Young Radiator Company—radiators.
Zenith-Detroit Company—carburetors.

General Equipment — Beam and briquet testing machines were shown by the Tinius Olsen Testing Machine Company. The Southwark Foundry & Machine Company showed in its exhibit the Huggenberger Tensometer, the Whittemore strain gage, the Beggs Deformeter, the McCollum-Peters electric Telemeter and a 60,000-lb. universal testing machine. Pittsburgh Testing Laboratories had an exhibit, and the Hamilton Manufacturing Company showed drafting room supplies.

The Concrete Surfacing Machinery Company exhibited a new gas engine operated grinder for removing surface irregularities from concrete and asphalt pavement and in addition its air- and electric-driven surfacers for various types of concrete structures. A new Berg electric generator was also shown by this company. The Blackhawk Manufacturing Company exhibited its hydraulic oil jacks and the McKiernan-Terry Drill Company exhibited its pile hammers ranging from small-sized units suitable for sheeting work up to a 7-ton hammer for heavy piledriving.

Form clamps and ties were exhibited by the M & M Wire Clamp Company and by the Richmond Screw Anchor Company. The W. F. Godwin Company showed its steel paving guards. Other exhibits of a general nature were those of the Lufkin Rule Company (rules and scales), the Niederst Company (crane and shovel toys), the Everhot Manufacturing Company (branding irons for marking construction tools), the Koehler Company (electric light plants), the South Bend Lathe Works (lathes), the Chicago Road Machinery Company (sleeping wagons for camp use), the Harley-Davidson Motor Company (motorcycles and side cars), the D-A Lubricant Company (oil preparations for gears, chains, ball and roller bearings, cables, etc.) and the Ric-Wil Company (pipe joint compounds).

Business Notes

T. L. Smith Company, Milwaukee, announces the purchase of the Kwik-Mix Concrete Mixer Company, Port Washington, Wis. The entire plant of the company at Port Washington will continue in operation with the exception of the business office, which will be combined with the T. L. Smith Company's Milwaukee office. By this acquisition the T. L. Smith Company now has a complete line of mixers, ranging from the 2½-S size to the 112-S tilter.

Chicago Pump Company, Chicago, Ill., announces the following distributors: Ace Combustion & Engineering Company, Shreveport, La.; Harry Cooper Supply Company, St. Louis, Mo.; F. L. Bunker, Greensboro, N. C.; L. Brandenberger, Salt Lake City, Utah; Alfred P. Brown, Seattle, Wash.; John A. Butler, Lynbrook, L. I.; Robert B. Brown, Newark, N. J., and J. J. Smith, Baltimore, Md.

The National Paving Brick Manufacturers Association will hold its 23d annual meeting in the Mayflower Hotel, Washington, D. C., Feb. 13-15. The program for the first two days will include papers and discussions of the latest practices in the design and construction of streets and highways, particularly the vitrified brick type. George F. Schlesinger, 1245 National Press Building, Washington, is chief engineer and managing director.